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02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics. **4176**

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Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences. **4196**

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Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation. **4211**

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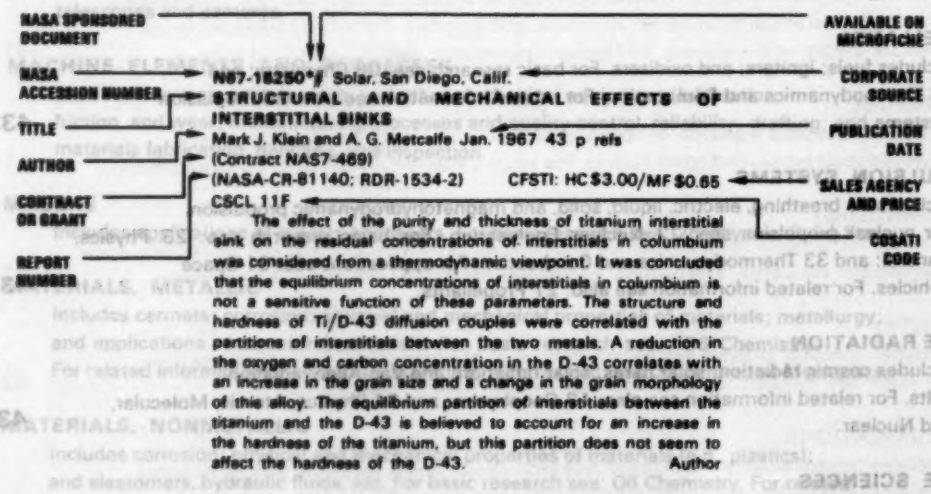
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N67-16250*# Solar, San Diego, Calif.
STRUCTURAL AND MECHANICAL EFFECTS OF INTERSTITIAL SINKS
Mark J. Klein and A. G. Metcalfe Jan. 1967 43 p refs
(Contract NAS7-469)
(NASA-CR-81140; RDR-1534-2)
CFSTI: HC $3.00/MF $0.65
CSCL 11F
The effect of the purity and thickness of titanium interstitial sink on the residual concentrations of interstitials in columbium was considered from a thermodynamic viewpoint. It was concluded that the equilibrium concentrations of interstitials in columbium is not a sensitive function of these parameters. The structure and hardness of Ti/D-43 diffusion couples were correlated with the partitions of interstitials between the two metals. A reduction in the oxygen and carbon concentration in the D-43 correlates with an increase in the grain size and a change in the grain morphology of this alloy. The equilibrium partition of interstitials between the titanium and the D-43 is believed to account for an increase in the hardness of the titanium, but this partition does not seem to affect the hardness of the D-43. Author

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01 AERODYNAMICS

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N67-38081# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

HYPERSONIC STABILITY DERIVATIVES FOR A STANDARD 10 DEGREE CONE

Otto Walchner, Frank Sawyer, Brian Quinn, and Eric Friberg May 1967 27 p refs

(ARL-67-0099; AD-657027)

The report describes experiments on the stability of an STA standard 10 degree cone. The free oscillation experiments on a sting mounted, open base model used an optron tracker to register the model's oscillation about zero angle of attack. Values of the static and dynamic pitching moment stability derivatives are given for independent combinations of nine initial oscillation amplitudes (between 1/2 degrees and 5 degrees), five reduced frequencies (omega D/2V between .0025 and .007), two pivot axis locations (X sub CG/L = 55% and 60%), and two nominal Mach numbers (M = 12 and 14). Author (TAB)

N67-38084*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TURBULENT-BOUNDARY-LAYER CHARACTERISTICS OF POINTED SLENDER BODIES OF REVOLUTION AT SUPERSONIC SPEEDS

Jerry M. Allen and William J. Monta Washington, NASA, Oct. 1967 109 p refs

(NASA-TN-D-4193) CFSTI: HC$3.00/MF$0.65 CSCL 01A

An experimental investigation was performed at free-stream Mach numbers of 1.61 and 2.20 over a free-stream Reynolds number range from 1.2×10^6 to 27×10^6 to determine the turbulent boundary layer characteristics of several pointed bodies of revolution, which included two slender cones, three parabolic-arc bodies with conical noses, two parabolic-arc bodies with no boattailing, and one parabolic-arc body with boattailing. Boundary layers on these bodies were surveyed at several longitudinal stations by means of static and pitot pressure probes. Zero angle of attack was maintained throughout the tests, which were conducted under conditions of zero heat transfer. Experimental integral thicknesses and local skin friction coefficients showed, in general, good agreement with those calculated from axisymmetric flow theory. Shape factors were approximately equal to flat-plate flow values. A slight increase in velocity profile index with free-stream Mach number was noticed. It was found that not accounting for the variation in inviscid pitot pressure through the boundary layer thickness resulted in errors in momentum thickness of as much as 5 percent and in displacement thickness of as much as 3.5 percent. Author

N67-38087 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STRENGTH AND DYNAMICS OF AVIATION MOTORS [ANALIZ USLOVIY VOZNIKNOVENIYA AVTOKOLEBANIY SISTEMY S ODNOY STEPEN'YU SVOBODY]

A. G. Zaslavskiy 18 Apr. 1967 118 p refs Transl. into ENGLISH from Sb. Statey Prochnost i Dinam. Aviats. Dvigateley (Moscow), no. 1, 1964 p 175–276

(FTD-MT-65-520; TT-67-62363; AD-655382)

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N67-38088 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ANALYSIS OF CONDITIONS OF APPEARANCE OF NATURAL OSCILLATIONS OF A SYSTEM WITH ONE DEGREE OF FREEDOM

A. G. Zaslavskiy *In its* Strength and Dyn. of Aviation Motors 18 Apr. 1967 p 1–43 refs (See N67-38087 23-01)

The appearance and development of natural oscillations of axial-flow compressor blades are analyzed using a mass profile mounted on an elastic rod with the oscillation perpendicular to the profile chord. Aerodynamic and mechanical damping forces are discussed, and nonlinear analytical expressions are presented. Van der Pol's method is applied to the solution of the equations of motion. Bifurcational diagrams are constructed to illustrate the influence of each parameter. Symmetric and asymmetric characteristics are investigated, and a power method is presented for determining the amplitudes of the natural oscillations. Motion of the profile is also considered when the profile turns around its own center of gravity simultaneously with the perpendicular displacement. N.E.N.

N67-38089 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CURVING-TWISTING OSCILLATIONS OF TWISTED COMPRESSOR BLADES

B. F. Shorr *In its* Strength and Dyn. of Aviation Motors 18 Apr. 1967 p 45–73 refs (See N67-38087 23-01)

The flexo-torsional oscillations of twisted working axial-flow compressor blades are calculated using the theory of twisted rods of extended or elongated profiles. The dependence between internal force factors and deformation is discussed, including shifts and equilibrium conditions. Special geometric blade characteristics are indicated. Rotating and nonrotating blades are treated separately in each discussion. Free oscillations of the blades are investigated, and conditions of orthogonality are mentioned. The stress behaviors with respect to increased torsion are described. A general method is presented for calculating the curving-twisting oscillations of twisted blades. N.E.N.

N67-38090 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CONDITIONS OF ACTIVATION OF STALL FLUTTER OF COMPRESSOR BLADES

L. Ye. Ol'shteyn and R. A. Shipov *In its* Strength and Dyn. of Aviation Motors 18 Apr. 1967 p 75–108 refs (See N67-38087 23-01)

The torsional stall flutter of blades in a grid is investigated. The joint twisting and curving deformations are considered along with the energy dissipation in blade and blade retainer. Aerodynamic forces during free oscillations with frequency close to that of a low natural mode are discussed. Necessary and sufficient conditions of actuation of natural oscillations are stressed, and methods of influencing the conditions of actuation are indicated. It is concluded that: (1) Self-actuation of the blades is possible only with negative force gradient at angles of incidence at which aerodynamic actuation exceeds aerodynamic damping. (2) The angle of incidence of initial natural oscillations essentially depends on oscillation kinematics. (3) Minimum magnitude of pressure at which natural oscillations can appear is determined by the level of mechanical damping. (4) The theoretical results agree with experimentally available data. N.E.N.

N67-38098# Aerospace Corp., El Segundo, Calif. Fluid Mechanics Dept.

A STUDY OF THE CHARACTERISTICS OF TRANSONIC BUFFET PRESSURES ON A LARGE HAMMERHEAD CONFIGURATION

H. E. Wang Jun. 1967 89 p refs

(Contract AF 04(695)-1001)

(TR-1001(2116-40)-1; SSD-TR-67-130; AD-657013)

The transonic fluctuating pressures over a large hammerhead configuration are investigated. The study examines existing experimental data on other configurations, presents fluid-mechanical arguments, derives a number of concepts and scaling parameters, and finally makes estimates of the fluctuating pressure characteristics for a large hammerhead configuration. The significant findings are as follows: (1) All the fluctuating pressure fields examined seem to indicate a strong influence of a square-wave type of random fluctuation in the low-frequency region; (2) a square-wave type of pressure fluctuation can arise from the random oscillation of the separation point because of stream-wise disturbances or cross-stream disturbances, or from the intermittency of a free boundary; (3) in a narrow range of high subsonic Mach numbers, a periodic modulation of the random pressure fluctuation can arise from shock-wave oscillation. (4) The turbulence field seems to have a "memory"—a short one at least. (5) The large eddies in the turbulence field apparently dominate the statistical properties; (6) the magnitude of the fluctuating pressures seems to be linearly dependent upon the mixing region or shear layer thickness and can be enhanced by a positive pressure gradient. (7) The unsteadiness of the separation surface behind the backward-facing step of a hammerhead configuration can be visualized as a series of "teeter-totters" lined up side-by-side around the perimeter and randomly going up-and-down. Thus, a revolving motion of the hammerhead about the flow axis might be induced. Author (TAB)

N67-38327*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

SOME EFFECTS OF MACH NUMBER AND GEOMETRY ON SONIC BOOM

Raymond H. Hicks, Joel P. Mendoza, and Lynn W. Hunton Washington, NASA, Oct. 1967 12 p refs Presented at the NASA Conf. on Hypersonic Aircraft Technol., NASA. Ames Res. Center, 16–18 May 1967

(NASA-TN-D-4214) CFSTI: HC $3.00/MF $0.65 CSCL 01B

A study has been conducted to determine the effects of Mach number and geometry on the level of sonic boom overpressure and on the applicability of the Whitham theory to the calculation of sonic boom. This study consisted of wind tunnel tests and a theoretical analysis of the sonic boom characteristics of a 7.5° half-angle cone cylinder and a model of the X-15 airplane over a Mach number range from 2 to 5.5 to compare experiment with theory. The geometric effect was examined in tests of three hypersonic transport configurations over the same Mach number range. This study shows the Whitham theory gives good predictions of sonic boom overpressure up to a Mach number of about 3, but deviates rapidly from experiment above a Mach number of 3. It also shows that configuration geometry can have a considerable influence on the level of sonic boom overpressure at low hypersonic Mach numbers. Author

N67-38395# Aerospace Research Labs., Wright-Patterson AFB, Ohio. Hypersonic Research Lab.

THE EFFECT OF SEVERE NOSE BLUNTNESS ON THE STABILITY OF SLENDER CONES IN HYPERSONIC FLOW

Brian Quinn May 1967 33 p refs

(ARL-67-0101; AD-657325)

The flow around a blunted slender cone performing pitching oscillations is theoretically analyzed by means of Chernyi blast-wave piston analogy. Stationary and transient shock shapes and pressure distributions are presented in power series form. Within the region of applicability, the stationary pressure agrees well with Chernyi numerical integration. Normal force and pitching moment coefficient derivatives are presented and the results are plotted for a 10 degree cone. The theoretical static and dynamic stability derivatives agree satisfactorily with recent experiments in a Mach 14 wind tunnel. It is concluded that the experimentally observed reduction in static and dynamic stability due to increased nose bluntness may be attributed to blast wave effects. Author (TAB)

N67-38551# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

AN INVESTIGATION OF AERODYNAMIC CONTROLS AT HYPERSONIC MACH NUMBERS

Anthony W. Fiore (Ph.D. Thesis—Ohio State Univ.) Feb. 1967 170 p refs

(ARL-67-0030; AD-657285)

A research program was conducted to investigate the behavior of a flat plate wing with a semi-cylindrical leading edge at a Mach number of 13.87 and a Reynolds number, based on the leading edge thickness, of 3935.0. The wing was investigated with both a trailing and leading edge control surface. Data were obtained at various combinations of angles of attack and control surface deflections. Pressure distributions for each control surface location, in the presence of combined separated and expansion type flow fields, were obtained. These pressure distributions were

integrated and the resulting two-dimensional force and moment coefficients, lift-to-drag ratio, and location of the center of pressure were compared with inviscid theory. The results of the research are presented in three groups: the first series of tests were conducted at various angles of attack for the case where the control surface was not deflected. The second series of data indicate the effect of cross-flow through an open gap between the wing and the control surface on the local pressure distribution. Finally, the third group of data present the experimental data with theoretical correlation of such parameters as control effectiveness and aerodynamic hinge moments for both the trailing edge and leading edge control surface location at various angles of attack. Author (TAB)

N67-38621 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

AERODYNAMIC DAMPING OF COMPRESSOR BLADES AND TURBINE BUCKETS [AMORTISSEMENT AERODYNAMIQUE DES AUBES DE COMPRESSEURS ET DES AILETTES DE TURBINES]

Robert Legendre 1967 17 p refs Presented at the Colloq. on Internal. Aerodyn. Turbomachines, Cambridge, Mass., 19–21 Jul. 1967

(ONERA-TP-493(1967))

After a short review of the work done on aerodynamic damping, the experimental results obtained in the laboratory are presented. Some important parameters are found and an unexpected frequency shift is made quite evident, although the accuracy of its measurement was not experimentally prepared. Some new theoretical developments are also summarized. Author

N67-38656* General Electric Co., Cincinnati, Ohio. Flight Propulsion Div.

SINGLE STAGE EXPERIMENTAL EVALUATION OF HIGH MACH NUMBER COMPRESSOR ROTOR BLADING. PART 5: PERFORMANCE OF ROTOR 2B

J. P. Gostelow and K. W. Krabacher 13 Oct. 1967 104 p refs

(Contract NAS3-7617)

(NASA-CR-54585; R67FPD278) CSCL 10A

A 1400 foot per second tip speed rotor with a 0.5 hub-tip radius ratio, designed to deliver a total pressure ratio of 1.76 and a rotor adiabatic efficiency of 0.837 at a flow of 215.49 lbs/sec, was tested with and without inlet flow distortion. For a point at design speed, judged to have adequate stall margin for engine operation, a total-pressure ratio of 1.763 and an adiabatic efficiency of 0.876 were achieved at a flow of 223.5 lbs/sec. The peak adiabatic efficiency of 0.885 at design speed occurred close to the stall line. Author

N67-38848*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STUDIES OF AIRFRAME–PROPULSION-SYSTEM INTEGRATION FOR MACH 6 CRUISE VEHICLES

Frank S. Kirkham, James M. Cubbage, Jr., Walter A. Vahl, and William J. Small Washington, NASA, Oct. 1967 22 p refs

(NASA-TN-D-4128) CFSTI: HC $3.00/MF $0.65 CSCL 01C

An exploratory, experimental, and analytic investigation of airframe–propulsion-system integration has been conducted at a Mach number of 6. A two-pod nacelle configuration, a four-pod nacelle configuration, and a two-dimensional nacelle configuration with and without boundary-layer diverters were tested at a Reynolds number sufficient to produce a turbulent boundary layer on the wing ahead of the nacelles. These preliminary results indicate no particular advantage of pod-type nacelles over two-dimensional designs and that the best over-all performance is obtained when the nacelle expansion area is no larger than the minimum required to enclose the turboramjet engines. A potential for significantly improving the lift-drag ratio of a configuration by utilizing the exhaust from underexpanded nozzles is also shown. Author

N67-38933 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

AERODYNAMIC STUDY OF HELICOPTER BLADE SECTIONS [ETUDE AERODYNAMIQUE D'UN ELEMENT DE PALE D'HELICOPTERE]

Philippe Poisson-Quinton and Alexandre de Sievers 1967 35 p refs In FRENCH; ENGLISH summary Presented at the AGARD Meeting on Aerodyn. of Vertical Take-Off Aircraft, Gottingen (West Germany), 11–13 Sep. 1967

(ONERA-TP-495(1967))

The aerodynamic calculation of a helicopter rotor requires knowledge of the two-dimensional aerodynamic characteristics of blade airfoil sections. Here, the main goal is to increase the maximum lift (retreating blade at a Mach number from 0.2 to 0.4), and to reduce the drag (advancing blade at M from 0.7 to 1), both subject to compressibility effects at high forward speed. A mounting for two-dimensional transonic tests is being built at the variable-density S3 MODANE wind tunnel to simulate local Mach and Reynolds numbers of a rotor in flight. Incompressible flow research dealt with manufacturing imperfections of a helicopter blade and with maximum lift and L/D improvements by means of a cambered nose section covering the symmetric airfoil. The theoretical calculation of the symmetrical and cambered profiles was carried out by rheoelectric methods in incompressible perfect flow. The good agreement between the electrical analogy computations and the experimental results shows that this method is useful for fast optimization of a family of profiles. Author

N67-39058# National Physical Lab., Teddington (England). Aerodynamics Div.

A COMPARISON BETWEEN PREDICTED AND MEASURED PROFILE DRAG FOR A TWO-DIMENSIONAL AEROFOIL AT INCOMPRESSIBLE SPEEDS OVER A LARGE RANGE OF REYNOLDS NUMBER

J. Osborne 20 Jan. 1967 11 p refs

(NPL-AERO-1052; ARC-28720)

Measurements of profile drag for a NACA $65_{(215)}$–114 aerofoil made in the Langley low turbulence pressure tunnel by the wake traverse method for Reynolds numbers between 6×10^6 and 4×10^7 are compared with predictions derived from two recent methods. Using observed boundary-layer transition positions good agreement is obtained between measured and predicted profile drag over the whole Reynolds number range. Author

N67-39155 Technische Hochschule in Graz (Austria). Fakultaet Fuer Maschinenwesen.

FLOW THROUGH A STRONGLY DEFLECTING GRID OF BLADES WITH PRESSURE INCREASE

Karl Pucher (Ph.D. Thesis) Apr. 1966 199 p refs In GERMAN

Theoretical and experimental studies were conducted in order to minimize the total pressure loss of a two-dimensional channel with a grid of blades in which the flow is deflected by 90° and whose exit cross section is 25% larger than the inlet. The effort was concentrated on obtaining an optimized contour for the blades of the grid. The theoretical design of the contour was based on approximate calculations of pressure and velocity distributions on the surface of the blades which would prevent a steep pressure increase and boundary layer seperation. The experimental structure was equipped with an axial fan, a diffuser, a smoothing chamber, and the inlet valve. The dimensions of the channel inlet were 0.212×0.2 m^2. Ten grids with different blade profiles were examined, two of which were made of synthetic resin and were profiled, and eight made of 1-mm-thick sheet metal. A comparison of the

results shows that the profiled blades performed somewhat better, particularly under conditions of overloading. For the design of such deflection blades it is recommended to proceed from the pressure distribution on the surface of the blade and to use the channel flow theory for calculating the blade contour. Transl. by K.W.

N67-39179 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DETERMINATION OF OUTLET OF ANGLE OF GAS FLOW FROM A FLAT TURBINE CASCADE DESIGN [OPREDELENIYE UGLA VYKHODA POTOKA GAZA IZ PLOSKOY TURBINNOY RESHETKI PROFILEY]
B. M. Aronov and B. I. Mamayev *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 109–122 refs (See N67-39169 23-32)

In this article functions are proposed for the determination of the discharge angle. These functions take into consideration the geometric peculiarities of the blade array, the compressibility of the gas, and the variable losses along the length of the channel. Formulas are derived which make it possible to determine the escape angle of the flow from a flat turbine blade array, both at subcritical and at supercritical discharge rates from the blade row. Author

N67-39284*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
AERODYNAMIC CHARACTERISTICS OF SEVERAL CRANKED LEADING-EDGE WING–BODY COMBINATIONS AT MACH NUMBERS FROM 0.4 TO 2.94
Edward J. Hopkins, Raymond M. Hicks, and Ralph L. Carmichael Washington, NASA, Oct. 1967 92 p refs
(NASA-TN-D-4211) CFSTI: HC $3.00/MF $0.65 CSCL 01A

Experimental lift, drag, and pitching-moment characteristics are presented for several wing–body combinations. The leading edges of the wings are two straight-line segments of different sweep angles (referred to as "cranked" planforms). As a basis for comparison, one combination had a wing of triangular planform. Each wing was planar and was mounted separately on a cylindrical body of revolution which had a Sears–Haack nose. Experimental results are presented for a Mach number range from 0.4 to 2.94 at a constant Reynolds number of 0.89 million. Results predicted by methods involving linear wing theories and slender-body interference effects are compared with the results measured at small angles of attack throughout the Mach number range. Large leading-edge extensions over the inboard portion of the wing span produced nonlinear pitching-moment curves. There were no other large effects of leading-edge extensions; however, a theoretical analysis indicated that warping should improve the lift-drag ratio of one cranked planform about 10 percent whereas the triangular planform should derive practically no benefit from warping. At low subsonic Mach numbers, practically no Reynolds number effect was indicated for the pitching-moment results obtained for two of the models at Reynolds numbers of 0.89 and 13.7 million. Author

N67-39288*# Pratt and Whitney Aircraft, West Palm Beach, Fla. Florida Research and Development Center.
SINGLE STAGE EXPERIMENTAL EVALUATION OF SLOTTED ROTOR AND STATOR BLADING. PART VIII: DATA AND PERFORMANCE FOR SLOTTED STATOR 3
13 Oct. 1967 95 p refs
(Contract NAS3-7603)
(NASA-CR-54551; PWA-FR-2288) CSCL 01A

A single stage investigation of a slotted stator was conducted as part of an overall program to evaluate the effect of slots on the performance of highly loaded compressor rotor and stator blade rows. A lightly loaded flow generation rotor was used to provide stator inlet flow. The stator vanes were 65-series airfoils having a calculated diffusion factor based on the turning for an unslotted vane of 0.704, and an inlet Mach number of 0.644 at a radial position 90% of the span from the vane tip. The measured stator total pressure losses were considerably higher than the predicted losses at all radial stations. Author

N67-39321 Royal Aircraft Establishment, Farnborough (England).
OSCILLATORY DERIVATIVE MEASUREMENTS ON STING-MOUNTED WIND TUNNEL MODELS AT R.A.E., BEDFORD
J. S. Thompson and R. A. Fail Jun. 1966 41 p refs
(RAE-TR-66197)

Derivative measurements on sting-mounted models have been made in various wind tunnels at R.A.E., Bedford over the last five years. This Report describes the present equipment, including a new spring unit for exciting and measuring oscillations in yaw, sideslip and roll at the same time, a new method of measuring the excitation force, certain improvements to accelerometers, and a fully automatic measuring and recording system. Results of a complete set of low speed derivative measurements are also given. Author

02 AIRCRAFT

Includes fixed-wing airplanes, helicopters, gliders, balloons, ornithopters, etc; and specific types of complete aircraft (e.g., ground effect machines, STOL, and VTOL); flight tests; operating problems (e.g., sonic boom); safety and safety devices; economics; and stability and control. For basic research see: 01 Aerodynamics. For related information see also: 31 Space Vehicles; and 32 Structural Mechanics.

N67-38154# National Research Council of Canada, Ottawa (Ontario). Low Temperature Lab.
THE EFFECT OF ICING DURING HELICOPTER GROUND RUN-UP
J. R. Stallabrass and R. D. Price Apr. 1967 8 p ref
(NRC-9692; MET-491) CFSTI: HC $3.00/MF $0.65

Tests were done in artificial icing conditions to determine what effects ice, accreted during ground running, had on the subsequent performance and handling characteristics of a helicopter. The results indicated that the helicopter used, a Bell 47G, was limited by the profile drag caused by ice on the main rotor blades, to the extent that, after only a few minutes exposure to icing at temperatures below about −10°C., flight was not possible. Author

N67-38182# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Flight Dynamics Lab.
EFFECTS OF GUST VELOCITY SPATIAL DISTRIBUTIONS ON LATERAL-DIRECTIONAL RESPONSE OF A VTOL AIRCRAFT Final Report, Oct. 1965–Feb. 1967
Robert L. Swaim and Alonzo J. Connors Jun. 1967 37 p refs
AFFDL-TR-67-93; AD-657321)

The effects of spanwise distribution of longitudinal and vertical components of gust velocity and longitudinal distribution of the lateral component on the lateral-directional response of a hovering VTOL aircraft are analyzed. Results show that spanwise effects of the longitudinal and vertical components are negligible, and the longitudinal distribution of the lateral component is significant in computing the power spectral densities of gust-induced side force, yawing moment, rolling moment, and the aircraft sideslip.

yaw, and roll root-mean-square response angles. If the gust-induced angles of attack and sideslip angles are in the nonlinear range of lift curve slope, the above conclusions, which are based on linear aerodynamic theory, may not hold and an analysis based on momentum transfer of gust energy to the aircraft is recommended. Flow field interaction effects due to engine intake and exhaust also were not considered. Author (TAB)

N67-38332*# Lockheed-California Co., Burbank.
STUDY ON THE FEASIBILITY OF V/STOL CONCEPTS FOR SHORT HAUL TRANSPORT AIRCRAFT
Washington, NASA, Oct. 1967 171 p refs
(Contract NAS2-3035)
(NASA-CR-902; LR-19586) CFSTI: HC $3.00/MF $0.65 CSCL 01C

The design, operational, and economic aspects of several different VTOL and STOL aircraft configurations were evaluated to determine which of the aircraft are most promising for development into successful commercial short haul transports. Aircraft were designed to carry 60 passengers for a distance of 500 statute miles, and other guidelines were established to assure that the vehicles would be studied on a common basis. The STOL aircraft included the deflected slipstream, jet flap, and fan-in wing configurations. The VTOL aircraft included tilt-wing, tilt-rotor, stopped-rotor and lift/cruise fan concepts. Parametric and detail design studies were made to provide a basis for selecting the optimum design characteristics of each concept. Extensive use was made of computers to map vehicle weights, dimensions, performance, and direct operating costs as functions of the design parameters. Several designs were selected from the initial data for further analysis, including development of 120 passenger configurations and more detailed design studies. The sensitivities of performance, weight, and cost to design changes and differences in mission rules were also examined. The basic characteristics of the final vehicles are shown. Author

N67-38367# Charles River Associates, Inc., Cambridge, Mass.
REVIEW OF THE ECONOMIC FEASIBILITY REPORT FOR THE SST AND SUPPORTING MATERIALS
3 Apr. 1967 130 p refs
(Contract FA-SS-67-18)
(CRA-122-1; AD-656935)

The review focuses on the aggregate demand for air travel in the period to 1990 and the demand for SSTs in the same period. An outline is given of the use of the IDA aggregate demand forecast. A description is given of the assumptions made in the application of a pricing decision methodology to the forecast of aircraft demand. Incidental findings are presented resulting from application of the RAC formulas to the problem of forecasting aircraft demand. TAB

N67-38428# Advisory Group for Aerospace Research and Development, Paris (France).
DESIGN, DEVELOPMENT, AND UTILIZATION OF GENERAL PURPOSE AIRBORNE SIMULATOR
Donald T. Berry (NASA, Flight Res. Center) and Dwain A. Deets (NASA, Flight Res. Center) May 1966 21 p refs Presented at the 28th Meeting of the AGARD Flight Mech. Panel, Paris, 10–11 May 1966
(AGARD-529) CFSTI: HC $3.00/MF $0.65

The general purpose airborne simulator is a variable stability and control Lockheed JetStar with a broad range of simulation capabilities. The various modifications and systems incorporated in the basic airplane include a model controlled system, response feedback system, variable feel system, electrohydraulic control surface servos, and electrochemical throttle servos. The model controlled system is the primary means of simulation since it offers reduced flight calibration time and ease of programing. This system uses an airborne analog computer which contains the programed model and generates the desired responses. Flexibility has been emphasized in all systems to insure a versatile vehicle. Initial flight tests confirm the ease of programing and versatility of the general purpose airborne simulator. The capability of simulating aircraft with longitudinal short period frequencies in excess of 1 cycle per second and Dutch roll frequencies in excess of 0.3 cycle per second has been demonstrated. Expected utilization emphasizes SST and B-70 applications. Author

N67-38582*# Boeing Co., Renton, Wash.
STUDY OF AIRCRAFT IN SHORT HAUL TRANSPORTATION SYSTEMS, VOLUME 1 Final Report
Aug. 1967 244 p refs
(Contract NAS2-3862)
(NASA-CR-73129; D6-58247-1, Vol. 1) CFSTI: HC $3.00/MF $0.65 CSCL 01C

A study was made of various advanced conceptual aircraft, ranging from vertical takeoff and landing through short takeoff and landing to conventional takeoff and landing types, to assess their relative suitability to perform short haul transport missions in the 1980's, including the effects of realistic route structures and system operations. The study also sought to determine the sensitivity of mission performance to changes in aircraft characteristics and system operations, and to identify key problems in which additional research may result in significant improvement in aircraft transportation systems. This report constitutes Volume I of two volumes and contains the objectives of the study, study constraints, the summary, conclusions, and discussions and recommendations. Also included are sections detailing the advanced technology assumed for 1985, and the determination and selection of the configurations. R.N.A.

N67-38583*# Boeing Co., Renton, Wash.
STUDY OF AIRCRAFT IN SHORT HAUL TRANSPORTATION SYSTEMS, VOLUME 2 Final Report
Aug. 1967 165 p refs
(Contract NAS2-3862)
(NASA-CR-73130; D6-58247-2, Vol. 2) CFSTI: HC $3.00/MF $0.65 CSCL 01C

Various advanced conceptual aircraft, ranging from vertical takeoff and landing through short takeoff and landing to conventional takeoff and landing types, were studied to assess their relative suitability to perform short haul transport missions in the 1980's, including the effects of realistic route structures and system operations. The study also sought to determine the sensitivity of mission performance to changes in aircraft characteristics and system operations, and to identify key problems in which additional research may result in significant improvement in aircraft transportation systems. This report contains Volume II of two volumes and covers the details on market analysis, vehicle and systems economics, and an analysis of the vehicles when applied to the transportation systems. R.N.A.

N67-38684# Bolt, Beranek, and Newman, Inc., Van Nuys, Calif.
DESCRIPTIONS OF FLYOVER NOISE SIGNALS PRODUCED BY VARIOUS JET TRANSPORT AIRCRAFT
Dwight E. Bishop Aug. 1967 66 p refs
(Contract FA-65-WA-1260)
(DS-67-18; FAA-DA-67-18)

Descriptions of aircraft flyover noise signals in terms of "effective perceived noise levels" or "integrated perceived noise levels" call for a more detailed analysis of the recorded aircraft

flyover signals than has previously been required. To provide a basis for comparing these relatively new measures with other flyover noise measures, this report provides descriptions of maximum levels and time durations for 45 flyover noise signals produced by a variety of turbojet and turbofan transport aircraft in current airline service. The descriptions are based upon one-third octave band noise spectra determined at one-half second intervals throughout the flyover time histories. Comparisons are provided between integrated perceived noise levels, effective perceived noise levels, perceived noise levels calculated from the maximum third octave band noise levels occurring during the flyover, and N-weighted noise levels. Comparison of various duration measurements and corrections are also presented for durations measured at levels of 10 dB and 20 dB down from the maximum flyover levels. Comparisons indicate high correlation among many of the different measures describing maximum noise levels and duration. Author

N67-38821*# National Aeronautics and Space Administration, Washington, D. C.

LANGLEY 50th ANNIVERSARY

1 Oct. 1967 12 p

(NASA News Release-67-251) Available from the Scientific and Technical Information Division CSCL 01B

Research and technology developments in aeronautics and astronautics are briefly summarized and the significant contributions made by the Langley Research Center in the past fifty years are cited. Dr. Langley's accomplishments are also mentioned. E.C.

N67-38841# Analytic Services, Inc., Baileys Crossroads, Va.

THE DOMESTIC AIR FREIGHT INDUSTRY AND INTRODUCTION OF LARGE SUBSONIC TRANSPORTS

D. H. Reecher Aug. 1967 157 p refs

This study examines the component functions of the domestic air freight system, its organizational elements and major customer service patterns, and coordination among the elements. The general industry characteristics considered include air freight traffic, and the attitudes, plans, and equipment of certificated passenger-cargo and all-cargo airlines with a high volume of air freight. The air freight forwarders are described, as are other important contributors to the operation and development of the industry. Representative forecasts of domestic air freight growth are given, and the industry's efforts to improve its service and meet the anticipated demand are discussed. The planned large subsonic jet transports (Boeing Model 747 and Lockheed L-500 series) are described; and their availability, general characteristics, economic performance, and the airlines' apparent preferences for various versions are presented. Supplemental airlines are briefly treated and a glossary of air transport terms used is given. Author

N67-38842# Boeing Co., Morton, Pa. Vertol Div.

REMARKS ON HIGH SPEED AND PAYLOAD CAPABILITY OF ROTARY-WING AIRCRAFT

W. Z. Stepniewski [1965] 35 p refs Presented at the AGARD Meeting on Helicopter Develop., NATO Headquarters, Paris

The high speed aspects, relative payload-time-on-station and relative payload-range characteristics, and the suitability of different configurations for various missions are discussed. The lift-to-drag ratios are considered, and ways of improving maximum speed of rotary wing aircraft are described. Based on payload considerations, it is suggested that for the given missions the following aircraft are most suitable: the compound and composite aircraft for missions requiring higher speeds on station; the current transport helicopters for short ranges of 200–300 nautical miles; and rotary wing aircraft for high speed, high altitude cruise over longer ranges. N.E.N.

N67-39039 College of Aeronautics, Cranfield (England). Dept. of Flight.

FREQUENCY RESPONSE OF AN AIRCRAFT AS DETERMINED FROM TRANSIENT FLIGHT TESTS USING THE FOURIER TRANSFORMATION METHOD OF ANALYSIS

D. W. Laurie-Lean May 1967 54 p refs

(Contract PD/28/028)

(CoA-Aero-175)

The longitudinal dynamic response characteristics of a twin engined propeller driven aircraft determined from flight measurements are presented and compared with predictions based on the theoretical studies. Transient responses to pilot applied pulsed motions of the elevator control surfaces were recorded. The transient data was then converted into frequency response form by means of the Fourier transformation and compared with predicted responses calculated from the basic equations of motion of the aircraft. In particular, detailed experience of the determination of frequency responses with regard to data sampling frequency and control input shape, using the Fourier transformation method, was obtained. Experimentally determined transfer functions were used for the evaluation of the stability derivatives that have the greatest effect on the dynamic response of the aircraft. Some experience was also obtained with automatic data recording and processing equipment using magnetic tape, but no satisfactory frequency responses were obtained using this method. However, with further development and use of this equipment, the analysis of large quantities of flight data would be facilitated. Author

N67-39061* Boeing Co., Renton, Wash. Commercial Airplane Div.

LARGE TRANSPORT APPROACH AND LANDING SIMULATION. DIRECT LIFT CONTROL APPLIED TO NOISE ABATEMENT APPROACHES. SUPERSONIC TRANSPORT HANDLING QUALITIES

Robert J. Bleeg, P. M. Condit, P. E. Decker, and Robert G. Root 22 Sep. 1967 185 p

(Contract NAS2-4200)

(NASA-CR-73148; D6-19581) CSCL 01C

Presented is a feasibility study on the use of the Boeing 367-80 as an inflight simulator for the study of large airplane longitudinal handling qualities in landing approach. Emphasized is the use of direct lift control as an aid in steep, noise abatement approaches; and the controllability of the supersonic transport during approach and landing. Author

N67-39173 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CALCULATION OF BALANCING LOSSES OF AERODYNAMIC QUALITY OF AN AIRCRAFT [UCHET BALANSIROVOCHNYKH POTER' AERODINAMICHESKOGO KACHESTVA SAMOLETA]

S. Yu. Skripnichenko *In its* News of Inst. of Higher Learning Aeron. Eng. 27 Apr. 1967 p 37–50 refs (See N67-39169 23-32)

In the present article, the author derives formulas for the balance polar and the maximum balancing L/D ratio of an aircraft. On the basis of expressions for maximum L/D ratio, the author determines the optimal values for the relative areas of compressed and floating horizontal tail surfaces for a minimum of L/D ratio balancing losses in the case of a conventional arrangement and a "duck" arrangement. Author

N67-39174 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DETERMINATION OF RELATIVE MASS OF FUEL AND THRUST/WEIGHT RATIO OF A FLIGHT VEHICLE AT THE GIVEN LAW OF ITS MOTION [OPREDELENIYE OTNOSITEL'NOY MASSY TOPLIVA I TYAGOVOORUZHENNOSTI LETATEL'NOGO APPARATA PRI ZADANNOM ZAKONE YEGO DVIZHENIYA]

L. S. Chernobrovkin *In its* News of Inst. of Higher Learning, Aeron. Eng. 27 Apr. 1967 p 51–64 refs (See N67-39169 23-32)

A solution to the problem of finding approximate algebraic expressions for relative fuel mass and thrust is proposed. This method is free of any constraints on the form of the trajectory of the aircraft. Assumptions are that (1) the angle of attack and the setting angle of the engine relative to the axis of the hull are small and (2) the specific thrust of the engine is constant and is equal to the mean value in the prescribed range of speeds. C.T.C.

N67-39261# Air Force Cambridge Research Labs., Bedford, Mass.

PROCEEDINGS, FOURTH AFCRL SCIENTIFIC BALLOON SYMPOSIUM

James F. Dwyer, ed. Jan. 1967 290 p refs Symp. held at AFCRL, Bedford, Mass., Sep. 1966 *Its* Special Rept.-51 (AFCRL-67-0075; AD-656692)

Conference papers are presented on atmospheric entry and meteorological balloons, and their structural material, failure analysis, design, deployment, and instrumentation. For individual titles see N67-39262–N67-39283.

N67-39262# Kaysam Corp. of America, Paterson, N. J.

RECENT DEVELOPMENTS IN HIGH-ALTITUDE METEOROLOGICAL BALLOONS

Eric Nelson *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 1–9 (See N67-39261 23-02)

Balloon test results, balloon capabilities, and carrier techniques are discussed. Day and night flight performance data is tabulated for the ML-537 (1200-g) and ML-564 (120G and 120GH) balloons, showing altitudes of above 120,000 ft and 140,000 ft respectively. A balloon made of a new compound is reported, and flight tests over West Germany indicate altitudes upwards of 150,000 ft, an ascent rate of 1000 ft/min, and flight time of 2-1/2 hours. The ML-566 carrier balloon consists of a high altitude balloon folded inside a two-piece streamlined balloon. The outer balloon is designed to burst at 50,000 ft. The carrier assembly has reached an altitude of 156,380 ft with an ascent rate of 1511 ft/min. The weight factors of the carrier assembly and its present limitation to daytime flights are mentioned. The reliability of balloons reaching 130,000 ft and an ascent rate of 1300 ft/min is considered demonstrated. N.E.N.

N67-39263# Air Force Cambridge Research Labs., Bedford, Mass.

BALLOON DEVELOPMENT FOR THE PLANETARY ENTRY PARACHUTE PROGRAM

James C. Payne *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 11–18 (See N67-39261 23-02)

The management of the balloon phase is reported for the development of the balloon capable of carrying the NASA payload to an Earth atmosphere comparable to the expected Martian atmosphere. The payload plans involve a weight of 1650 lb for the aeroshell, 600 lb for the control and safety equipment, and 1200 lb ballast. Materials were surveyed, and Mylar with 440-denier reinforcing fibers in pattern 4334 design was chosen. The tandem design consists of launch balloon and main balloon. Test flight results are given, and altitudes in the 125,000 ft range and ascent rate near 900 ft/min are reported. N.E.N.

N67-39268*# National Aeronautics and Space Administration, Langley Research Center, Langley Station, Va.

PLANETARY ENTRY PARACHUTE TESTING USING A BALLOON AS A LAUNCH PLATFORM

M. C. McFall, Jr. *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 69–73 (See N67-39261 23-02) CSCL 01C

A 28 million cu ft balloon was designed, constructed and tested for use as a launch platform. The fabric weight of the balloon is less than 0.0055 lb/sq ft allowing a payload of 2,250 lb to be carried to an altitude of approximately 130,000 ft. The parachute tests to be conducted with this balloon system are a part of the NASA Planetary Entry Parachute Project in support of Project Voyager. In these tests, a 15-ft-diam simulated Voyager landing capsule with parachute system (84-ft constructed diameter parachute) will be launched with a tandem balloon system and carried to 130,000 ft. Following release from the balloon, rockets in the capsule will accelerate it to the required test conditions of Mach no. 1.2 and dynamic pressure of 5 lb/sq ft. The test parachute will be ejected from a mortar, and an aeroshell will be released from the instrumented internal body. On-board and ground-based instrumentation will record the system performance. Author

N67-39269# National Center for Atmospheric Research, Boulder, Colo.

BALLOON STRESS-BAND ANALYSIS

Harold L. Baker *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 75–98 (See N67-39261 23-02)

Balloon failures near the tropopause were photographed, and the data obtained were analyzed to provide better understanding of mechanisms of failure. The test program unexpectedly revealed the presence of a circumferential stress band in certain balloons which failed catastrophically in flight. The band in each case was located between the top of the balloon and the equator of the bubble, and appeared to exert powerful transverse stresses on the envelope, culminating in failure near the tropopause level. The failure mechanism appeared to involve also the presence, beginning at launch, of a large asymmetrical pocket of undeployed material, which locally folded the envelope inward approximately as far as the vertical axis of symmetry of the balloon. With expansion during ascent this excess material was gradually deployed into the inflated balloon structure. Failure appeared to occur about at the point where there was no longer sufficient excess material to allow the pocket to extend to the vertical axis of symmetry. It is speculated that the additional work then involved in deploying the remainder of the pocket, together with film brittleness due to cold temperatures at tropopause level, and aided at least in some instances by shear winds, combined to produce failure by enhancing transverse stresses at the stress-band level. Author

N67-39279# National Center for Atmospheric Research, Boulder, Colo.

BEGINNING STUDIES OF BALLOONS AT OFF-DESIGN CONDITIONS

Justin H. Smalley *In* AFCRL Prov., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 203–214 (See N67-39261 23-02)

Rotationally symmetric balloons made of nonextensible material are investigated. Computer calculations were performed and the shapes of the balloon under conditions of excess payload and excess lifting gas, and of diminished payload and diminished gas were determined. The changes in stress and in volume with change in payload were calculated, and the center of gravity and center of buoyancy were determined. The shapes and stresses of the balloon as it rises in altitude are also presented. N.E.N.

N67-39280# Air Force Cambridge Research Labs., Bedford, Mass.
FIFTY MILLIBAR BALLOON TRAJECTORIES
Ivar A. Lund *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 215–232 refs (See N67-39261 23-02)

Twice daily 50-mB grid-point height data were used to objectively estimate trajectories of superpressure balloons. The computed trajectories were regarded to be sufficiently representative of actual trajectories and streamlines to conclude that a useful climatology of 50-mB balloon trajectories could be derived from grid-point height data of the type generated by the third weather wing. Author

N67-39282# Air Force Cambridge Research Labs., Bedford, Mass.
BALLUTE RETARDATION DEVICE FOR METEOROLOGICAL ROCKETSONDES
John B. Wright and John J. Graham, Jr. (Goodyear Aerospace Corp., Akron, Ohio) *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 239–277 refs (See N67-39261 23-02)

The basic aerodynamic and structural aspects of the Ballute are discussed, and some current applications are cited. The Ballute was developed into configurations suitable as substitutes for conventional silk parachutes used to retard falling rocketsondes. The evolution of these Ballutes is described in this paper. Test data from flights of the Arcasonde and Loki-Dartsonde Ballute systems are used to show performance with respect to descent rate, stability, telemetry reception, weight, and volume. By extrapolation of current flight performance envelopes, a preview of the Ballute potential in meteorological sounding technology is described. Author

N67-39283# Little (Arthur D.), Inc., Boston, Mass.
THE MEASUREMENT OF HIGH-ALTITUDE BALLOON GAS TEMPERATURE
R. M. Lucas and G. H. Hall *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 279–293 refs (See N67-39261 23-02)

A test flight was conducted to obtain balloon gas and air temperatures. The necessary flight parameters were then used to fly the mathematical model and the output of this digital program, altitude, and gas temperature, were compared to the measured values. The resulting correlation indicates that the mathematical model is sufficiently accurate to predict the vertical motion of high-altitude balloons providing the local air temperature profile is known. A preliminary test program was conducted to evaluate the thermistor characteristics, to provide the necesary calibrations, and determine the possible measuring errors. Author

N67-39370* Boeing co., Renton, Wash. Commercial Airplane Div.
A DIRECT LIFT CONTROL FLAP FOR THE 367-80 AIRPLANE
C. R. Taylor and C. C. Flora 19 Sep. 1967 76 p
(Contract NAS2-4200)
(NASA-CR-73147; D6-19580) CSCL 01C

The results of a preliminary design study of a direct lift control flap system for the Boeing 367-80 aircraft are presented. General descriptions of the flap modifications and auxiliary flap actuation and control are given followed by design details of the flap system structural rework, mechanisms, hydraulics, and electrical-electronic system modifications. An autothrottle system design is briefly discussed. Detailed design analyses are included on the proposed modified flap system aerodynamics, airloads and hinge moments, and hydraulic actuation system. R.N.A.

03 AUXILIARY SYSTEMS

Includes fuel cells, energy conversion cells, and solar cells; auxiliary gas turbines; hydraulic, pneumatic and electrical systems; actuators; and inverters. For related information see also: 09 Electronic Equipment; 22 Nuclear Engineering; and 28 Propulsion Systems.

N67-38132# Union Carbide Corp., Parma, Ohio. Technical Center.
EXPLORATORY DEVELOPMENT MODEL MINIATURE HYDROGEN GENERATOR Semiannual Report, 1 Nov. 1966–30 Apr. 1967
Jack E. Rothfleisch Jul. 1967 60 p
(Contract DAAB07-67-C-0114)
(ECOM-0114-1; Rept.-1; AD-655913)

The purpose of this contract is to design, fabricate, qualify, and deliver two Exploratory Development Models of a miniature hydrogen generator for use with hydrogen/air fuel cells in the power range of 10 to 200 watts. Hydrogen will be generated by thermally cracking JP-4. This report covers the work done during the period 1 November 1966 through 30 April 1967 on Contract No. DAAB07-67-C-0114. As a result of the experimental program conducted during this period, the design, fabrication, and testing of a disposable nickel reaction vessel meeting all of the performance requirements of the contract has been successfully completed. In addition, a conceptual design of the overall hydrogen generator system was developed and experimental qualification of the individual system components including the furnace, burner, fuel tank and controls initiated. Assembly of a breadboard model is in progress and extended testing of this unit will begin shortly. Author (TAB)

N67-38155# National Research Council of Canada, Ottawa (Ontario). Engine Section.
GAS TURBINE CYCLE CALCULATIONS: DIFFERENTIAL METHODS IN THE ANALYSIS OF EQUILIBRIUM OPERATION
E. P. Cockshutt Mar. 1967 64 p refs
(NRC-9666; LR-481)

The equilibrium operation of a simple turbojet engine is analyzed, using logarithmic differential methods to infer performance changes about a design point. A simple method, assuming constant specific heats and ignoring mass addition effects, is compared with a more rigorous analysis where both these effects are considered; it is shown that the computation of fuel flow, at least, should follow the rigorous analysis. The application of the analysis is illustrated by considering the performance response of a turbojet engine as the air flow is reduced. The effects of simple mass flow change and simple compressor efficiency change are considered separately, and superposition to determine the combined result is illustrated. Extensive changes of cycle parameters (CPR and TIT), and component efficiencies (η_c and η_t), are shown to have only small changes on engine thrust and sfc response; somewhat stronger effects are associated with changing the engine flight condition. Author

N67-38181# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
RADIATION DAMAGE TO ORBITING SOLAR CELLS AND TRANSITORS
R. E. Fischell, J. H. Martin, W. E. Radford, and W. E. Allen Mar. 1967 33 p refs
(Contract NOw-62-0604-c)
(TG-886; AD-657155)

In-flight solar cell degradation studies began with the launching of the 1961-01 satellite on June 29, 1961. Similar experiments were flown on the 1961-alpha eta and 1961-alpha eta 2 satellites.

Data obtained from these satellites cover a time period both before and after Operation Starfish on July 9, 1962. Subsequently solar cell and electronic experiments were flown on satellites 1962-beta eta, ANNA I-B, 1963-38C, and 1964-83C. The data indicate that the damage to solar cells in a 1000 km orbit during the early months after Operation Starfish may not have been mostly a result of fission spectrum electrons. Although many energetic electrons were introduced into the inner belt, it is indicated that some high energy (>4.5 mev) protons were redistributed to altitudes including 1000 km. The results of flight experiments indicate that optimum power-to-weight ratio solar arrays will be obtained by use of N-on-P solar cells with 6 mil glass covers. Author (TAB)

N67-38246# Harry Diamond Labs., Washington, D. C.
AN ACTIVE FILTER FOR FUZE POWER SUPPLIES
Joseph A. Kreck Jun. 1967 40 p
(HDL-TM-67-14; AD-656926)

Ripple, noise, step changes in voltage, and high AC impedance are common faults of fuze batteries which can be corrected by the use of ripple filter. A low-cost filter can attenuate these undesirable signals by at least 20 dB. The ripple filter acts as a capacitance multiplier, and gives the effect of producing a large shunt capacitance across the battery. The filter reduces the AC impedance of the battery without affecting its DC internal resistance. This report covers a convenient design procedure as well as theory and performance. Author (TAB)

N67-38290# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
CONVERSION OF EXPLOSIVE ENERGY INTO ELECTROMAGNETIC ENERGY [CONVERSION D'ENERGIE EXPLOSIVE EN ENERGIE ELECTROMAGNETIQUE]
Jean Bernard (Ph.D. Thesis—Paris Univ., Orsay, France, 21 Dec. 1966) Mar. 1967 59 p refs in FRENCH
(CEA-BIB-85)

The phenomenon of conversion of explosive energy into electromagnetic energy is described for devices with compression of magnetic field by explosives, devices with ferromagnetic or ferroelectric transducers, and MHD devices with explosives. The advantages of the use of such devices for very high powers of short duration are discussed. The principles, the theoretical models, and the experimental studies made on each of the three devices are summarized. NSA

N67-38313# Bowles Engineering Corp., Silver Spring, Md.
FLUIDIC AC AMPLIFIERS Final Report, Apr. 1966–May 1967
Larry R. Moore, James J. Zaloudek, and Robert F. Turek Jun. 1967 120 p refs
(Contract DA-49-186-AMC-325(D))
(R-6-28-67; HDL-325-1; AD-656934)

Several fluidic tuned AC Amplifiers were designed and tested. Interstage tuning and feedback designs are considered. Good results were obtained with vented flow amplifiers using interstage tuning. Single stage elements demonstrated gains as high as 35 db at resonence (600 to 1300 hz) with corresponding Qs as high as 12. Element designs and test results of one, two, and three stage amplifiers are presented. AC Modulated Carrier Systems offer potential advantages over DC amplifiers which include higher gain per stage, lower drift and better noise rejection. To achieve this, high gain, narrow-band amplifiers are required. It is concluded that fluidic amplifiers with low impedance characteristics are necessary. Author (TAB)

N67-38328* Electro-Optical Systems, Inc., Pasadena, Calif.
HYDROGEN–OXYGEN ELECTROLYTIC REGENERATIVE FUEL CELLS
Robert F. Astrin and Martin G. Klein 10 Aug. 1967 19 p
(Contract NAS3-2781)
(NASA-CR-89181; EOS-4110-ML-38) CSCL 10A

A phase of fuel cell development is described during which emphasis was placed on the testing of single cells with matrix structures of potassium titanate, Teflon, asbestos, and polypropylene. A cycling H_2 concentration cell test was completed, and a reference cell was assembled and tested. Briefly mentioned are plans for fabricating a 28-volt, 500-watt prototype fuel cell assembly. K.W.

N67-38402* Northeastern Univ., Boston, Mass.
LIQUID METAL SELF-HEALING FUSE Final Report
C. A. Renton 15 Jun. 1967 18 p
(Contract NAS12-750)
(NASA-CR-85025) CSCL 19A

A repetitive exploding wire system that acts as a self-healing is described. It consists of two reservoirs connected together by a heavy walled capillary tube and filled with mercury. Excessive current passed between the two reservoirs causes evaporation of the mercury within the capillary tube. The evaporation provides sufficient force to eject mercury from the tube and thus sever the electrical connection. Subsequently, the mercury will refill the tube and so reset the fuse. Prototype models of this fuse are reported and recommendations for further development are made. Author

N67-38425*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
INVESTIGATION OF THE DYNAMICS OF WATER REJECTION FROM A HYDROGEN–OXYGEN FUEL CELL TO A HYDROGEN STREAM
Paul R. Prokopius and Norman H. Hagedorn Washington, NASA, Oct. 1967 26 p refs
(NASA-TN-D-4201) CFSTI: HC $3.00/MF $0.65 CSCL 10A

A water rejection dynamics study of a hydrogen–oxygen fuel cell was conducted using both experimental and analytical techniques. In the type of cell studied, water resulting from the fuel cell reaction diffuses as a vapor through a porous electrode and is removed by circulating gaseous hydrogen. The experimental investigation was conducted by introducing step transients in the rate of water production and in the inlet humidity of the water removal gas stream, while holding all other cell operating parameters constant. The resulting water rejection transients were measured as changes in outlet stream humidity. These transients were very slow, taking 1 hour or longer to reestablish a steady state operating condition in which the water being removed by the hydrogen steam just equals that formed by the cell reaction. Step transients were also introduced with the electrolyte at an initial dried-out condition, which caused a slowing down of the rejection response. In the analytical portion of the study, a mathematical model of the water rejection mechanism was derived. The resulting model is in the form of a linear, first order differential equation. When the various dimensions and operating conditions of the cell tested were substituted for the corresponding constants of the mathematical model, its step response was calculated and was found to compare well with the experimental data. Author

N67-38493*# Electro-Optical Systems, Inc., Pasadena, Calif.
LIGHTWEIGHT SOLAR PANEL INTERCONNECTIONS Final Report, 11 May 1966–1 Mar. 1967
S. A. Friedlander and R. N. Hanson Aug. 1967 41 p
(Contract NAS5-10187)
(NASA-CR-89133; EOS-7088-Final) CSCL 10A

Basic electroforming techniques are reported for attaching a silver interconnection to single 12.5-mil wraparound or

conventional solar cells, between two solar cells, and between four solar cells. The interconnections passed contact pull and thermal shock tests. Feasibility studies were conducted on 2×2 cm n–p silicon solar cells, using sintered Ti–Ag contacts. The physical properties of electroformed silver and copper are given, and mandrel and masking materials and techniques are reported. It was concluded that successful interconnections can be obtained by the electroforming process. A discussion on silver-lume bright silver plating process is included. N.E.N.

N67-38494*# General Electric Co., Philadelphia, Pa. Missiles and Space Div.

COMPARISON OF DIRECT CONDENSING AND INDIRECT RADIATORS FOR NUCLEAR RANKINE SYSTEMS

R. D. Cockfield and R. E. Killen 26 Jul. 1967 78 p refs
(Contract NASw-1449)
(NASA-CR-72318; GE-ANSO-6300-251) CFSTI: HC $3.00/MF $0.65 CSCL 10B

A weight comparison is made between direct condensing radiators and indirect systems for nuclear potassium Rankine systems at a power level of 300 kWe and for meteoroid nonpenetration probabilities of 0.9, 0.99, and 0.999 for five years. The direct condensing radiators have a significant weight advantage for all conditions considered. However, consideration of startup requirements favor the indirect system and may offset the apparent advantage of the direct condensing system. The use of redundant loops in the indirect system provides a means of reducing radiator weight. A study is made to select the optimum redundancy arrangement. Author

N67-38495# Westinghouse Electric Corp., Youngwood, Pa. Semiconductor Div.

INVESTIGATION OF LARGE AREA DENDRITIC WEB TYPE GERMANIUM PHOTOVOLTAIC CELLS Quarterly Report, 15 Jul.–15 Oct. 1966

Y. Ichikawa, T. Merritts, and N. Ernick Jun. 1967 40 p refs
(Contract DA-28-043-AMC-02350(E))
(ECOM-02543-1; Rept.-1; QR-1; AD-655912)

The report reviews design considerations that should yield high performance large area thermophotovoltaic cells on germanium web dendrite material. Process techniques related to germanium web growth for TPV cells are described. Initial effort on junction formation by the alloying and diffusion processes is reported. Author (TAB)

N67-38617*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

A 2000°F LITHIUM EROSION AND COMPONENT PERFORMANCE EXPERIMENT

L. G. Hays and D. O'Connor 1 Oct. 1967 36 p refs
(Contract NAS7-100)
(NASA-CR-89234; JPL-TR-32-1150) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Results of a 2000°F lithium erosion experiment are presented, together with a discussion of performance of high temperature flow components and instrumentation. The main objective of the experiment was to evaluate the resistance to lithium impingement of candidate separator materials for a liquid metal magnato-hydrodynamic power system. After 100 hours duration with impingement velocities in the range of 110–150 ft/s, significant attack was observed on four hard materials which had exhibited long-term compatibility with static lithium. Another material (Cb-1%Zr alloy) was very resistant to impingement velocities of 150 ft/s and flow channel velocities up to 270 ft/s. Performance data for a helical induction pump and electromagnetic flowmeter operating at 2000°F were obtained which agreed well with predicted performance. Author

N67-38822*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.

RESEARCH AND ADVANCED DEVELOPMENT. VOLUME II: SUPPORTING RESEARCH AND TECHNOLOGY FOR THE OFFICE OF ADVANCED RESEARCH AND TECHNOLOGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION Semiannual Review, 1 Jan.–30 Jun. 1967

31 Jul. 1967 631 p refs
(Contract NAS7-100)
(NASA-CR-88968; JPL-TM-33-353, Vol. II) CFSTI: HC $3.00/MF $0.65 CSCL 10B

Supporting research and technology projects being carried out at the Jet Propulsion Laboratory are reviewed in detail. Progress is reported under the following systems: space power and electric propulsion, space vehicle, electronics, human factors, chemical propulsion, chemical rocket experimental engineering, and fluid physics, electro physics, and materials research. E.C.

N67-38849*# Duke Univ., Durham, N. C. Dept. of Electrical Engineering.

ANALYSIS OF PERFORMANCES FOR STATIC POWER-CONDITIONING SYSTEMS—INVERSION, CONVERSION, AND REGULATION

Yuan Yu (Ph.D. Thesis) 31 Jan. 1967 169 p refs
(Grant NsG-152-61)
(NASA-CR-88975) CFSTI: HC $3.00/MF $0.65 CSCL 10A

Analytical and experimental investigations were conducted on three power conditioning systems: (1) the Marzolf tunnel diode inverter for voltage setup, (2) an efficient simple dc to dc regulated converter using the principle of inductive energy storage, and (3) a lightweight self-regulating dc to sine wave inverter using techniques of high frequency pulse width modulation. The following results were obtained: (1) an understanding of the significance of the source inductance as a circuit element in the Marzolf inverter, its effect, and its relationship with the zero voltage step interval associated with the induced voltage waveform of the inverter; (2) an analytical comparison of frequency ranges among different types of variable frequency dc to dc regulated converters using the principle of inductive energy storage in their inverter stages; (3) an understanding of the ringing phenomenon in converters using the principle of inductive energy storage during light load conditions; and (4) analytical proof of negligible harmonic amplitudes which provides the mathematical foundation of the pulse-width modulation technique as applied to dc to sinusoidal ac inversion. Author

N67-38923*# Yardney Electric Corp., New York.

STUDY TO INVESTIGATE AND IMPROVE THE ZINC ELECTRODE FOR SPACECRAFT ELECTROCHEMICAL CELLS Quarterly Report, 1 Feb.–30 Apr. 1967

James McBreen Aug. 1967 25 p refs
(Contract NAS5-10231)
(NASA-CR-89312; QR-3) CFSTI: HC $3.00/MF $0.65 CSCL 10C

An investigation of the absorption and transport of zincate in separator membranes is presented. The growth of dendritic zinc through separators is correlated with the deposition of zinc in free electrolyte and the absorption and transport of zincate through the membranes. The addition of the surfactant, Emulphogene BC-610, does not affect the absorption of zincate in cellophane. The diffusivity of zincate through six membranes was measured. The diffusion coefficient for zincate in the separators tested was approximately directly proportional to the conductivities of the membranes. Zinc penetration tests on various separators indicate that the over-voltage at which zinc penetration of the membrane occurs has an inverse relationship to the diffusivity of zincate in the membrane. The cycling of cells on a scanner, using −150 mV as a cutoff on the zinc electrode resulted in penetration of cell membranes after 14 cycles. Author

N67-38938*# Dynatech Corp., Cambridge, Mass.
THE USE OF FLOW-THROUGH ELECTRODES IN A HIGH CURRENT DENSITY HYDROGEN–OXYGEN FUEL CELL STACK Final Report, 5 Dec. 1966–5 Apr. 1967
Adrian R. Reti and Shafik Sadek 12 Jun. 1967 44 p refs
(Contract NAS7-530)
(NASA-CR-89298; Rept.-719; Rept.-617-868-8050) CSCL 10C

An analytical study was made of the performance of a flow-through-electrode hydrogen–oxygen fuel cell stack to compare the potential system weight with other power sources, and to determine if there is a mission duration for which the use of flow-through electrodes is advantageous. An efficiently packaged system, operating at electrolyte saturator pressures of 10 to 50 atm, was found which should deliver 300 to 500 watt-hours/lb of total system weight for a 24-hr mission, and 100 to 150 watt-hours/lb for a 5-hr mission. The system appears to have no advantages for longer missions. Overall system performance was calculated with confidence; however, electrode performance should be confirmed experimentally, since the calculations are based on simplified idealized structures. The saturator performance also needs experimental confirmation to ascertain whether any flow or side leakage problems are encountered with such controlled wetting structures. The total system weight was relatively insensitive to electrode current density in the 0.15 to 0.40 ampere/cm^2 range. The optimum saturator pressure was between 20 and 50 atm for all cases. R.N.A.

N67-38985*# Dayrad Lab., Dayton, Ohio.
TESTING AND EVALUATION OF NICKEL–CADMIUM SPACECRAFT-TYPE CELLS Final Technical Report, 6 May 1966–6 May 1967
William G. Ingling and Ronald L. Koesters 6 May 1967 33 p refs
(Contract NAS5-10213)
(NASA-CR-89314) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The life and performance characteristics of hermetically sealed nickel–cadmium space craft batteries were evaluated. Initially all test batteries were made up of 10 cells each. Seven batteries were in the test at the beginning and four at the ending of the continued effort. The maximum number of cycles successfully completed was over 23,010. The −10°C tests performed better than the 25°C tests. Leaks and corrosion account for most failures. Author

N67-38988*# Mauchly Systems, Inc., Montgomeryville, Pa.
NiCd SPACE BATTERY TEST DATA ANALYSIS PROJECT, PHASE 2 Quarterly Report, 1 Jan.–30 Apr. 1967
J. H. Waite and S. D. Epstein 30 Apr. 1967 47 p
(Contract NAS5-10203)
(NASA-CR-89323; QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10C

NiCd cell-failure-characteristic data, for cells made by four battery-cell manufacturers, was computer examined by a technique of cryptology or cryptanalysis. This is a new use of cryptanalytic technique which was previously only used by security agencies to break ciphers and codes. The Crane failure characteristic reports were assumed to contain hidden information or information not readily extractable by manual analysis. This assumption proved correct when the data was treated like a code or cipher. Application of cryptanalytic technique extrapolated information which identified specific cell failure mechanisms accountable to individual battery-cell manufacturers. This procedure, referred to in this report as TRI-GRAM Failure Characteristic Technique is applicable to any coded data. Cell failure characteristic/cycling environmental parameter analysis will be performed to correlate failure mechanisms with single and combined environmental effects. Author

N67-39045*# General Electric Co., Schenectady, N. Y. Chemical Systems and Processes Lab.
STUDY OF NICKEL–CADMIUM CELLS Final Report
W. N. Carson, Jr., J. A. Consiglio, and J. F. Wilfore Jul. 1967 126 p
(Contract NAS5-9586)
(NASA-CR-89310; S-67-1116) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Variations in the positive nickel–hydroxide electrode behavior and the effect of selected impurities on the performance of sealed nickel–cadmium cells were investigated. The principal performance characteristics investigated were the capacity and gassing rate of the positive electrodes and sealed test cells in selected cycling modes. The capacity distribution for the positive electrodes was determined by cycling 300 electrodes under constant current charge–discharge for 6 consecutive cycles. The effect of extended cycling on the capacity distribution was determined by cycling some of the electrodes for an additional 25 cycles. The rate of oxygen evolution from the positive electrodes was determined as a function of the state of charge of the electrode over the course of six to twelve cycles. Parameters investigated were capacity, cycling history, the presence of selected impurities, and the mode of cycling. Author

N67-39064*# Leesona Corp., Great Neck, N. Y. Moos Labs.
THE IMPROVEMENT OF ZINC ELECTRODES FOR ELECTROCHEMICAL CELLS Final Report, 3 Jun. 1966–31 Oct. 1966
S. Arouete and K. F. Blurton 31 Oct. 1966 54 p refs
(Contract NAS5-9591)
(NASA-CR-89316) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Studied was the growth of zinc dendrites during the charging of silver/zinc batteries in order to improve the life cycle of the batteries. Two forms of dendritic growth were observed, which are referred to as dendrites and moss. The former is grown under diffusion control conditions, the latter under activation control conditions. The transition from one type of growth to the other occurs at a critical current density which is a function of temperature. The parameters governing adherence, propagation, and type of growth were studied. The adherence of the deposit was increased by pulse charging conditions, by soaking the electrode in potassium hydroxide solution for 18 hours, by decreasing the height of the electrolyte, and by adding a lead salt to the electrolyte. Correlation was established between the adherence of the deposit and the variation of the electrode overpotential with time. An explanation is proposed for the growth mechanism of the two dendrite forms and for the beneficial effect of pulse charging. K.W.

N67-39070*# Union Carbide Corp., Parma, Ohio. Research Lab.
SECONDARY ZINC–OXYGEN CELL FOR SPACECRAFT APPLICATIONS Quarterly Report, 23 Sep.–23 Dec. 1966
23 Dec. 1966 47 p refs
(Contract NAS5-10247)
(NASA-CR-89311; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 10C

The test program has shown that the zinc–oxygen system is rechargeable with good voltage regulation over a range of cycle regimes. In the two-hour discharge/two hour charge cycle, over 50 cycles were obtained above 1.0 volt terminal discharge voltage at a zinc depth of 14% with 10 ampere-hour cells. Deeper zinc discharge depth to 28% of theoretical was demonstrated with the twenty-four hour discharge/twenty-four hour charge cycle. Use of a membrane type C-3 separator was a factor achieving the cycle life on the two-hour discharge/two-hour charge regime. A re-design of the unit test cell so as to seal the zinc electrode behind the C-3 film separator, in a chamber inaccessible to oxygen bubbles, effectively prevents oxygen from chemically shorting the cell. The

cells are operated in a flooded condition with a nickel charging electrode to prevent oxidation of carbon catalyst in the fixed-zone oxygen electrode. Cycling performance evaluations were initiated in which the cells have undergone 4 two-hour discharge/two-hour charge cycles at 0°C, and 9 cycles at 40°C at a discharge depth of 14%. Author

N67-39129*# Mauchly Systems, Inc., Montgomeryville, Pa. Industrial Center.
COMPUTER METHODS FOR THE REDUCTION CORRELATION AND ANALYSIS OF SPACE BATTERY TEST DATA Final Report, 1 May–31 Dec. 1966
J. W. Mauchly and J. H. Waite 31 Dec. 1966 127 p
(Contract NAS5-10203)
(NASA-CR-89322) CFSTI: HC $3.00/MF $0.65 CSCL 10C

This report describes the computer techniques developed to extract information from large volumes of spacecraft battery test data. Novel statistical methods (application of cryptanalytic-like processes) have been used to identify failure mechanisms from descriptions of failed cells, and to predict cell life from data patterns hidden in the test data. Computer programs have been written to reduce the cell test data for a desired interval of time or for any selected measurement parameters, and to produce output documentation easy to understand by the spacecraft design engineer. The results of these programs include specific predictions of failure, many thousands of cycles before actual failure, from less than 1000 cycles of data. Author

N67-39238*# Gulton Industries, Inc., Metuchen, N. J. Alkaline Battery Div.
DEVELOPMENT OF PILE TYPE, HIGH DISCHARGE RATE NICKEL–CADMIUM SQUIB BATTERIES Final Report, 4 Mar. 1966–4 Aug. 1967
S. Charlip and A. Lyall 4 Aug. 1967 73 p refs
(Contract NAS5-10160)
(NASA-CR-89327) CSCL 10C

The objective of this program is the development of small size, thick sinter, five cell bipolar nickel–cadmium, sealed, rechargeable batteries to deliver a one second pulse at 10 amperes above 5 volts for squib activation. A minimum capacity of 150 mAh at the 10-hour rate was required. The report emphasizes the work of developing thick bipolar electrodes, .030 inch sinter, in circular shapes, capable of being impregnated to a capacity of 150 mAh/in^2 of sinter area. The development of a bonded rubber-to-metal seal permitted the construction of ten 5-cell modules, fully encapsulated, which yielded several pulses with current densities of 3.6 A/in^2 above 5 volts, for electrode sizes of 2.76 in^2. Single bipolar cells and five-cell batteries were tested, vented, and sealed. Based on laboratory cell test data, concentration and activation polarization are the limiting parameters of current density outputs in a bipolar nickel–cadmium battery. Author

N67-39303*# Yardney Electric Corp., New York.
STUDY TO INVESTIGATE AND IMPROVE THE ZINC ELECTRODE FOR SPACECRAFT ELECTROCHEMICAL CELLS Quarterly Report
Z. O. J. Stachurski Jun. 1967 38 p refs
(Contract NAS5-10231)
(NASA-CR-89299: QR-1) CFSTI: HC $3.00/MF $0.65 CSCL 10C

Electrodeposition of zinc on slowly rotating disc electrodes was conducted. The half wave potential ($E_{1/2}$) on the current-potential curve was confirmed to be the critical value for change from mossy deposition to dendritic. The radius of the dendrites was measured as a function of overpotential and found to change radically around $E_{1/2}$. Absorption isotherms of zincate in five separators were measured. The distribution coefficient of zincate between electrolyte and separator was measured and found to be less than one. Its value varied over a factor of five for different separators. Author

N67-39304# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
ELECTROHYDRODYNAMICS: A HIGH-TENSION DIRECT ENERGY CONVERSION PROCESS [L'ELECTROHYDRODYNAMIQUE: UN PROCEDE DE CONVERSION DIRECTE D'ENERGIE A HAUTE TENSION]
Serge Brun Apr. 1967 47 p refs In FRENCH
(CEA-R-3158)

This analysis consists of a theoretical and practical study of a high-tension electrical power generator based on the Van de Graaff generator principle, the main difference being that the charges produced are transported by a gas in motion and not by a belt. The electrical and thermal properties of such a generator are studied, as well as the production of the ionised particles used in the conversion. Some results already published on this process for converting kinetic energy into electrical energy are given, as well as some possible applications in the field of space technology. Author (NSA)

N67-39340*# Union Carbide Corp., Cleveland, Ohio. Fuel Cell Dept.
DEVELOPMENT OF FUEL CELL ELECTRODES. PRELIMINARY SYSTEM DESIGN Final Report
J. D. Grigsby, G. E. Smith, and N. Hilvety 30 Jun. 1967 234 p refs
(Contract NAS3-9430)
(NASA-CR-72305) CSCL 10A

A preliminary system design is presented of a free electrolyte, hydrogen–oxygen fuel cell system capable of operating in a space environment including zero gravity. The powerplant was sized to have a nominal output of 5 kw at 28 volts and an overload capability of 8 kw. No specific mission was assigned to the system; however, the goal was to establish a design which would be capable of realizing 3000 hours of reliable operation over a varying load profile. The design evolved takes into consideration the shock, vibration, acceleration and accoustical noise requirements typical of a space vehicle launch. Work on the thermal control sybsystem is documented along with an engineering analysis of the over-all system, its performance, operating conditions, projected weight and preliminary layout drawings. A brief description of each of the major system components is also presented. Author

N67-39365 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
ROTATING STALL IN AXIAL FLOW COMPRESSORS [LE DECOLLEMENT TOURNANT DANS LES COMPRESSEURS AXIAUX]
Jean Fabri 1967 36 p refs In FRENCH; ENGLISH summary
Presented at the Colloq. on Internal Aerodynamic Turbomachines, Cambridge, Mass., 19–21 Jul. 1967
(ONERA-TP-492(1967))

The onset of rotating stall in axial flow compressors can be described as no through flow bubbles and that their speed of rotation can be deduced from the static pressure rise across the non stalled blades. Radial equilibrium condition of the bubbles defines the critical flow rate at which rotating stall may become steady. Calculation of the pressure rise in a solid body bleding, friction and off design losses being taken into account, gives a correct description of the phenomenon. Steady flow regime lasts until at high pressure ratio the stall limit is not attained; rotating stall regime corresponds to low flow coefficients and both regimes

are stable in an intermediate flow coefficient range. In the case of a free vortex blading, the theory shows that the rotating stall cells extend only on part of the blade span, at least when the hub-tip ratio of the compressor is small. Author

04 BIOSCIENCES

Includes aerospace medicine, exobiology, radiation effects on biological systems; physiological and psychological factors. For related information see also: 05 Biotechnology.

N67-38071# Army Natick Labs., Mass. Technical Library.
MOISTURE EQUILIBRIUM IN RELATION TO THE CHEMICAL STABILITY OF DEHYDRATED FOODS: A BIBLIOGRAPHY
Eugene G. Beary, comp. Jan. 1967 146 p refs *Its* Bibliographic Ser. 67-1
(AD-656927)

A bibliography is presented with abstracts of 380 references on moisture equilibrium in relation to the chemical stability of dehydrated foods. Author and detailed subject indexes are provided. Author (TAB)

N67-38102# School of Aerospace Medicine, Brooks AFB, Tex.
BODY VOLUME OF ADULT MEN
Chester L. Ward Jun. 1967 5 p refs
(SAM-TR-67-42; AD-657316)

Body composition determinations were made on 404 adult men by use of a volumetric method. The testing of a proposed nomogram for estimation of body volume from height and weight revealed the chart to be biased for adult men. Body volume was found to correlate well with body weight (correlation coefficient of .996). Body volume of men in liters, V, may be estimated from body weight in kilograms, W, by using the formula: $V=-4.7573+1.0153\ W$. The ideal weight given on the USAF standard weight table was found to have a correlation coefficient of only .672 with calculated percent body fat. Author (TAB)

N67-38124* Scientific Translation Service, La Canada, Calif.
HEMATOLOGICAL CHANGES IN HEALTHY PEOPLE DURING MUSCLE WORK (THE MYOGENIC LEUCOCYTOSIS) [DIE VERAENDERUNG DES BLUTBILDES WAEHREND DER MUSKELARBEIT BEI GESUNDEN (DIE MYOGENE LEUKOCYTOSE)]
A. Egoroff Washington, NASA, Oct. 1967 21 p refs Transl. into ENGLISH from Z. Klin. Med. (Heidelberg), v. 100, 1924 p 485–497
(Contract NASw-1498)
(NASA-TT-F-11294) CSCL 06S

Tests were made to determine the character of myogenic leucocytosis in relation to muscle work. A blood picture is sometimes observed after strenuous muscle work which is a sign of "myogenic intoxication" of the myeloid tissues. Author

N67-38143# School of Aerospace Medicine, Brooks AFB, Tex.
ALLERGY AND SINUS DISEASE IN AVIATORS
Frederick G. Collins and Morgan E. Wing May 1967 5 p refs
(SAM-TR-67-47; AD-657312)

The paper covers all aeromedical consultation cases seen at the USAF School of Aerospace Medicine during the period December 1960 to July 1965. This study is concerned primarily with the occurrence of nasal allergy and chronic sinus disease in aviators. Evaluation of the history as given by the patient, diagnosis of the disease (allergy or sinusitis) present, and a comparison between incidence of cases in both disease areas are presented. Age and flying time in both jet and reciprocal aircraft were not found to be significantly related to the incidence of chronic sinusitis. Author (TAB)

N67-38184*# National Aeronautics and Space Administration, Washington, D. C.
AEROSPACE MEDICINE AND BIOLOGY. A CONTINUING BIBLIOGRAPHY WITH INDEXES
Sep. 1967 168 p refs
(NASA-SP-7011(41)) CFSTI: HC $3.00/MF $0.65 CSCL 06S

Abstracted material dealing with the biological, physiological, psychological, and environmental effects on man during simulated or actual flight is presented in a continuing bibliography with indexes. Related topics such as: sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors are consider. Assembled are groups of references formerly announced in separate journals for use by medical and biological scientists. Entries are obtained from NASA, American Institute of Aeronautics and Astronautics, and the Library of Congress. S.P.

N67-38251# Naval Medical School, Bethesda, Md.
MECHANORECEPTORS [MEKHANORETSEPTORY]
O. S. Il'inskii Jun. 1967 100 p Transl. into ENGLISH from Vopr. Fiziol. Sensornykh System (Leningrad), 1967 82 p
(NMS-TRANS-2034; TT-67-62583; AD-658918)

An attempt is made to review in detail studies on mechanoreceptors, and in the light of these data, to discuss certain general principles in the organization and in the functioning of these sensory structures. TAB

N67-38325*# Alabama Agricultural and Mechanical Coll., Normal.
RADIATION EFFECTS ON THE METABOLISM OF PHOSPHOLIPIDS IN THE CENTRAL NERVOUS SYSTEM OF ALBINO RATS. MECHANISM OF ACTION OF X-RAYS ON PHOSPHOLIPIDS AND PRECURSORS Progress Report, Jan. 1–Jun. 30, 1967
Charlotte O. Lee 23 Sep. 1967 17 p refs
(Grant NGR-01-001-003)
(NASA-CR-89073; PR-4) CSCL 06R

Studies on the isolation and characterization of breakdown products formed as a result of X-irradiation of phospholipids and precursors are presented. Chromatogram plates containing the compounds ceramide, lysolecithin, phosphatidylserine, ethanolamine, choline chloride, and other phospholipids were irradiated directly; and chromatographic separation was completed in from five to twenty-six hours post radiation. G-values were calculated in some instances. Author

N67-38338 Atomic Energy Establishment, Winfrith (England). Radiological and Safety Div.
THE MEASUREMENT OF PLUTONIUM-239 "IN VIVO" Progress Report
D. Ramsden and R. G. Speight Apr. 1967 31 p refs
(AEEW-R-494)

Experience in the operation of a prototype system for the detection and estimation of insoluble plutonium-239 in the lungs is described. The system consists of a low background xenon-filled, multiwire proportional counter used in conjunction with a large area, thin windowed, sodium iodide crystal. A realistic chest phantom is used to calibrate the detectors for plutonium-239 and

americium-241. The variations in detector backgrounds caused by the presence of a human subject are described, and the sources of error and their magnitude arising both from the detection system and the calibration procedure are discussed in detail. The use of the equipment in a few cases of accidental inhalation of plutonium-239 is described. The limit of detection of the present equipment is given as 0.012 μCi Pu-239. The effect, on the lung detectors, of plutonium in the liver is briefly considered. Improvements in the chest phantom are suggested following an ultrasonic investigation of the soft tissue thickness on the chests of human volunteers of widely varying body builds. Author

N67-38382# California Univ., Livermore. Lawrence Radiation Lab.
THE QUANTITATIVE NATURE OF THE RELATIONSHIP OF CORONARY ARTERY ATHEROSCLEROSIS AND CORONARY HEART DISEASE RISK
John W. Gofman May 1967 19 p refs
(Contract W-7405-ENG-48)
(UCRL-50270) CFSTI: HC $3.00/MF $0.65

Quantitative considerations of the nature of the relationship of coronary heart disease (CHD) risk and degree of coronary artery atherosclerosis are reported. The methodology for determination of CHD risk from distributions of atherosclerosis in population groups and their respective CHD cases is presented in detail. The calculation of expected distribution of CHD cases is the inverse, if risk and base population distribution are available. Neither a linear rise in risk with increase in degree of atherosclerosis nor a more rapid than linear rise in risk is consistent with the observations concerning CHD. A sigmoid type of risk curve, with CHD risk rising rapidly at a particular degree of coronary atherosclerosis does explain the observations of Strong and his collaborators that CHD cases show comparable degrees of atherosclerosis even though they arise from base population groups differing widely in average degree of atherosclerosis. The implication for prophlaxis is that a marked drop in CHD risk and incidence might be achieved if degree of coronary atherosclerosis is kept to values just below the steeply rising portion of the CHD risk curve. Author

N67-38386# School of Aerospace Medicine, Brooks AFB, Tex.
BEHAVIORAL CHANGES IN RATS AT GROUND LEVEL FOLLOWING GESTATION AND GROWTH IN 100% OXYGEN AT REDUCED PRESSURES Final Report, Mar. 1966–Jan. 1967
Julian P. Cooke and William E. Pepelko Jun. 1967 11 p refs
(SAM-TR-67-50; AD-657029)

After removal from a hypobaric normoxic environment (an altitude chamber containing 97% O2 at a total pressure of 210 torr or 210 mm. Hg. absolute), exploratory activity of rats conceived, born, and raised in such an environment was measured from photographic light tracings made during the animals movements. Within 15 minutes after the first encounter with room air at ground level, experimental animals displayed more exploratory activity than ground-level controls. No differences were measured 4 hours later, but a reduced amount of exploratory behavior occurred after 1 days exposure to room air at ground level. The extra amount of work necessary to ventilate the lungs owing to increased turbulence in the more dense air at ground level is believed to result in initial excitement and hyperactivity, followed by a reduction in movement as tiring occurs. Adaptation to room air at ambient pressures has apparently not been completed within 22 hours following a previous growth to maturity in a hypobaric normoxic environment. Author (TAB)

N67-38390# Monsanto Research Corp., Dayton, Ohio.
MINERAL NUTRIENT REQUIREMENTS OF CHLORELLA SOROKINIANA IN CONTINUOUS PURE CULTURE Final Report, 1 Apr. 1964–29 Apr. 1966
H. Clyde Eyster Brooks AFB, Tex., School of Aerospace Med., 1 May 1967 60 p refs
(Contract AF 41(609)-2414)
(SAM-TR-67-40; AD-657031)

Mineral nutrient requirements of Chlorella sorokiniana under suitable sterile conditions were studied in a photothermostat and in two continuous culture units at constant densities of 2 microliters/ml. and 20 microliters/ml. Minimum, optimum, and maximum concentrations for each of the following essential elements are reported: N, P, Mg, S, K, Fe, Ca, Mn, Zn, and Cu. Additional studies with B, Mo, Co, Na, Cl, and ethylenediaminetetraacetate (EDTA) are also reported. Optimum nutrient requirements were compared at growing temperatures of 25 and 39C., and at 4.8% and 0.51% concentrations of carbon dioxide in air. The hydrogen ion requirement was determined. An optimal medium was formulated and evaluated in sterile photothermostatic and pure continuous cultures. The effluent medium was reconstituted after each harvest by replenishing the supernatant medium with essential elements and then was returned to the culture. Author (TAB)

N67-38391# Washington Univ., Seattle.
REPORT OF PROGRESS NUMBER 5
Eugene Galanter 1 Jun. 1967 18 p refs
(Contracts Nonr-477(34); DA-49-193-MD-2713)
(PRP-34NA; AD-657305)

Progress is reviewed on problems of visual and auditory perception, memory, animal psychophysics, and human and animal reaction time. TAB

N67-38403# Washington Univ., Seattle.
EFFECTS OF COMPONENTS OF DISPLACEMENT STEP STIMULI UPON LATENCY FOR SACCADIC EYE MOVEMENT
Michael G. Saslow 1 Sep. 1966 25 p refs
(Contract Nonr-477(34))
(PRP-28N; AD-657299)

The standard displacement step stimulus often used to produce lateral saccadic eye movements is considered in terms of the effects of its components: termination of stimulation at an initial fixation point, and onset of stimulation at a new, laterally displaced fixation point. If the termination and onset are simultaneous, saccade latency is about 200. msec. If there is a gap of 200. msec. or more between these events, latency decreases to about 150. msec. If the termination follows the onset by 100. msec. or more, latency increases to about 250. msec. Author (TAB)

N67-38416* Arizona Univ., Tucson. Lab. of Tree-Ring Research.
AN EVALUATION OF POSSIBLE RELATIONSHIPS BETWEEN SOLAR ACTIVITIES AND TREE-RING GROWTH IN WESTERN NORTH AMERICA Semiannual Report
Harold C. Fritts Sep. 1967 8 p
(Grant NGR-03-002-101)
(NASA-CR-88972) CSCL 02F

Proceedings from a seminar on "Solar-Dendroclimatic Relationships" are discussed and results of statistical analyses of various seminar-related topics are summarized. A topic outline for the seminar is included. It is concluded that predicting future sunspot variability and establishing relationships between tree rings and sunspots should be based on variability having a frequency of 20 or more years. Long term tree ring variance is considered to have good potential for predicting sunspot activity. E.C.

N67-38422*# Washington Univ., Seattle.
AN EXPERIMENTAL CRITIQUE OF THE METHOD OF CONSTANT STIMULI AND SOME ALTERNATIVE PROCEDURES
Don A. Ronken [1967] 44 p refs Sponsored in Part by NASA
(Contract Nonr-477(34))
(NASA-CR-89282; PRP-31N; AD-657301) CSCL 05J

Some experiments investigating the constant error demonstrate that the method of constant stimuli is especially unsuited for studying such small effects of discrimination. The nature of the confounded data from the classical procedure suggests that the difficulty is of a fundamental nature and can be expected to influence the data under less stringent conditions as well. Some data from the literature are offered to support this view. Several alternative procedures are developed and evaluated experimentally, the most promising of which is shown to be a form of the XAB method.
Author (TAB)

N67-38429*# Research Triangle Inst., Durham, N. C. Engineering and Environmental Science Div.
BIOMEDICAL APPLICATIONS TEAM Quarterly Progress Report, 15 Jun.–14 Sep. 1967
J. N. Brown, Jr. et al 14 Sep. 1967 23 p
(Contract NSR-34-004-045)
(NASA-CR-89265; EU-349; QPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 06B

Activities of the Biomedical Applications Team this period with respect to specific biomedical problems are outlined. These activities are concerned with correction for latency in vidicons, a microforce transducer, pressure transducers for intra-cavity or subcutaneous implantation in the body, a signal conditioning and multiplexing system for multiple electrode EKG patient monitoring, simulation of coronary infarctions in experimental animals, a system for recording and performing simple data processing of evoked action potentials in smooth muscle tissue, fluid dynamics of sucrose gap chambers, methods of fabricating small sucrose gap chambers, preparing metallic powders from silver alloys, a sensor to measure teeth temperature to determine their viability, a method of obtaining single X-ray films of entire mouth, techniques of applying thermography to the mouth, photographing ultrasonic energy patterns, theoretical treatments of holography, continuous monitoring of capillary and small artery diameters, measuring velocities of red cells, methods for facilitating needle insertion into small arteries and veins, and a survey of transducers for monitoring physiological parameters.
R.N.A.

N67-38431* California Univ., Berkeley.
[A SYSTEMS ANALYSIS STUDY OF THE PROPERTIES OF VEINS] Semiannual Progress Report, 1 Apr.–30 Sep. 1967
Loren D. Carlson 5 Oct. 1967 7 p
(Grant NGR-05-004-031)
(NASA-CR-88978) CSCL 06C

Progress on a systems analysis approach to the study of the venous circulatory system is reported. All equipment has been assembled and is operable with the exception of the tape recorder and its amplifiers. Efforts are underway to formulate and construct a model for use as an analog and for simulation of a peripheral segment of the arm, hand, or leg. This systems approach is a formal way of proposing a hypothesis and of assigning values to known variables and parameters. Lumping and linearizing approximations are required in this system.
R.N.A.

N67-38436# Washington Univ., Seattle.
OPERANT CONTROL OF RESPONSE LATENCY IN MONKEY: PERIPHERAL VS CENTRAL EXPLANATIONS
Carol A. Saslow [1966] 26 p refs
(Contract Nonr-477(34); Grants PHS GM-666-06; NIH FR-00166; NIH MH-06722)
(PRP-32N; AD-657302)

Two monkeys were trained to press a telegraph key in response to a tone and release it quickly to a subsequent light or click stimulus occurring after a variable interval. After training with a self-adjusting limited hold, minimum reaction time to click was 160 msec. and to light about 200. Temporal contingencies or payoff bands were then introduced which reinforced only latencies falling between two limits 50 msec. apart. Feedback was given as to whether the response latencies were too slow, on target, or too fast relative to the payoff band. A trained animal could precisely center his latency distribution on any 50-msec.-wide payoff band located from 200 to 800 msec. after the stimulus, with from 60 to 80% of his response latencies achieving reinforcement. Distribution statistics were comparable to those of trained human subjects. Because such precise timing might be accomplished by peripheral adjustment such as changing manner of holding key, latency of EMG activation was measured in participating arm muscles. EMG activation preceded key release by a constant interval, regardless of response latency, indicating a more central mechanism for timing of brief intervals.
Author (TAB)

N67-38446 Rome Univ. (Italy).
STUDY OF THE CORRELATIONS BETWEEN CHROMOSOME ABERRATIONS AND DOSE IN SUBJECTS IRRADIATED FOR THERAPEUTIC PURPOSES [STUDIO DELLE CORRELAZIONI FRA LE ABERRAZIONI DEI CHROMOSOMI E LA DOSE NEI SOGGETTI IRRADIATI A SCOPO TERAPEUTICO] Annual Report, Jul. 1965–Jul. 1966
C. Biagini (Sassari Univ.), P. Brancadoro, and A. Siciliano Brussels, EURATOM, Aug. 1967 38 p refs In ITALIAN; ENGLISH summary
(Contract EURATOM-035-64-5 BIOI)
(EUR-3499.i)

The object of this research is to obtain quantitative information from the analysis of peripheral blood chromosomes of subjects exposed to part-body irradiation treatment. Groups of patients were studied before exposure and 24–72 hours after a single irradiation with doses varying from 10 to 1000 rad. The fragments, dicentrics, chromosome breaks, complex anomalies, and the average number of breaks per anomalous cell were taken into consideration. An evaluation was also made, in the same samples, of the frequency of tetraploid as against diploid cells. The data were analyzed as a function of the skin dose and the integral dose. In spite of a high degree of variability in the data, the results show that aberrations increase with the dose, more noticeably as regards the number of fragments and the average number of breaks per anomalous cell. A study, limited to the persistence of aberrations at distances of time, was also conducted on a group of patients after a complete course of radiotherapy for malignant neoplastic forms.
Author

N67-38460*# Northrop Corp., Hawthorne, Calif.
INVESTIGATION OF PEROGNATHUS AS AN EXPERIMENTAL ORGANISM FOR RESEARCH IN SPACE BIOLOGY Summary Progress Report, 3 Jan.–30 Sep. 1967
R. G. Lindberg 30 Sep. 1967 19 p refs
(Contract NASw-812)
(NASA-CR-85367; NCL-67-60R) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Hypoxia induced hypothermia and hemoglobin oxygen affinity in the genus *Perognathus* were investigated. Details are presented on the techniques of obtaining blood samples from the pocket mice, and on the procedures for determining oxygen content. Whole, undiluted, and unbuffered blood at 41 mm CO_2 pressure was used. It was found that: (1) The *P. longimembris*, *P. formosus*, and

P. fallax are able to rewarm from artificially induced hypothermia at a level well into the range occupied by a classical hibernator. (2) The half saturation values of the oxygen dissociation curve of whole blood generally fall within the expected range based on size. (3) Variation of hemoglobin–oxygen affinity at the species level is as great as the variation in intraspecific comparisons. (4) No direct correlation between high blood–oxygen affinity and ability to rewarm from induced deep hypothermia was noted. N.E.N.

N67-38492*# Stanford Univ., Calif. Dept. of Aeronautics and Astronautics.
DYNAMIC BEHAVIOR OF EYE GLOBES
Robert H. Tuffias and Max Anliker Feb. 1967 147 p refs Sponsored in Part by NASA
(Contract N00014-C-00017-0007; Grant NIH NBO-6328-01)
(NASA-CR-89004; SUDAAR-302; AD-657382) CSCL 06P

The eye globe was treated as a spherical shell (combined cornea and sclera) filled with (vitreous and aqueous) and surrounded by (tissue and fat) incompressible, inviscid, irrotationally flowing fluids. Its dynamic behavior was investigated by making use of the Flugge shell equations and the appropriate inertia terms. The axisymmetric case was solved in closed form, and the asymmetric case was solved numerically. Some qualitative results for physiologically meaningful parameter values are given. Static and dynamic experiments were performed on enucleated dog eyes. The static experiment measured the change in volume of the eyes as a function of time at various pressures. The results of this experiment indicated that the eyes were viscoelastic with an associated time constant of approximately 20 minutes. Author (TAB)

N67-38513# National Academy of Sciences–National Research Council, Washington, D. C.
ECOLOGICAL BIOLOGY IN RELATION TO THE MAINTENANCE AND IMPROVEMENT OF THE HUMAN ENVIRONMENT
G. Evelyn Hutchinson *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 171–183 refs (See N67-38508 23-34)

Efforts to apply modern knowledge of ecological and evolutionary biology to promote human welfare are explored, and the very nature of ecology is discussed in terms of autecology and synecology (or systems ecology). Some aspects of the ecology of the atmosphere are included; and responsibility, understanding, and economics are mentioned in brief. Under psychological difficulties, fluorides and politics are noted; and under intellectual difficulties, an understanding of the population explosion is included. The roles of science, government, and education are considered; along with the general aims of present-day society. M.W.R.

N67-38514# National Academy of Sciences–National Research Council, Washington, D. C.
APPLIED SCIENCE AND MEDICAL PROGRESS
Maurice B. Visscher *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 185–206 refs (See N67-38508 23-34)

Basic and applied sciences are considered in terms of how they can contribute to the greatest overall progress in medical fields, and some pertinent questions are asked to stress the need and value of basic research endeavors. Is applied research in medicine being neglected? How have some major practical advances in medicine come about? A chronological approach to the rubella (German measles) vaccine research is detailed, and the basic research efforts that preceded the vaccine are noted. Both serendipity in medical research and the problem of priorities are also noted, as are some present and impending impediments to progress in applied research in medicine. Finally, problems of management and planning in medical research, both basic and applied, are discussed. M.W.R.

N67-38628# Oak Ridge National Lab., Tenn. Biology Div.
FACTORS AFFECTING CELL INJURY IN CRYOSURGICAL FREEZING
Peter Mazur [1967] 9 p Presented at the Conf. on Cryobiol. and Cryosurgery, Buffalo Submitted for publication
(Contract W-7405-ENG-26)
(ORNL-P-3103; CONF-670529-1) CFSTI: HC $3.00/MF $0.65

A discussion is presented on the physico-chemical factors underlying injury in single cells at sub-zero temperatures: effects of lowered temperature and events in single cells during ice formation and methods for maximizing the effectiveness of cryosurgical freezing. It was concluded that the likelihood of killing all cells in a target area could probably be increased by subjecting the target to two or more cycles of freezing (below −20°C) and slow thawing. NSA

N67-38659# Washington Univ., Seattle.
SYSTEMATIC BIASES IN EYE MOVEMENT LATENCY DATA
M. G. Saslow and C. A. Saslow [1966] 9 p refs
(Contract Nonr-477(34))
(PRP-27N; AD-657297)

The investigation was designed to estimate systematic time trends over sets of hundreds of trials, and to suggest methods for their compensation, in the study of human lateral saccadic eye movements. A disjunctive latency paradigm, with four mutually exclusive lateral displacements from a central fixation point, was in use in order to combat time estimation biases often found in simple latency paradigms. Author (TAB)

N67-38660*# Hazleton Labs., Falls Church, Va.
A STUDY TOWARD DEVELOPMENT OF AN AUTOMATED MICROBIAL METABOLISM LABORATORY Final Report, 1 Oct. 1966–31 Aug. 1967
31 Aug. 1967 232 p refs
(Contract NASw-1507)
(NASA-CR-88989) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Metabolic parameters for life detection have been successfully demonstrated by phosphate uptake, sulfate uptake, and ATP production of Earth-born microorganisms using RM9-$^{35}SO_4$-S medium. Phosphate uptake was determined by measuring decrease of phosphate concentration in supernatant of the test medium. Sulfate uptake was shown by accumulation of $^{35}SO_4$-S in cells. ATP production was demonstrated by ATP assay of the cells extracted by DMSO through subsequent injection of the extracted ATP into firefly luciferase, luciferin, and other reagents for light response. Author

N67-38809* Swift and Co., Chicago, Ill. Research and Development Center.
[ADVANCED BLADDER TECHNOLOGY] Interim Report Ending 31 Jul. 1967
Harland H. Young 31 Jul. 1967 33 p
(Contract NAS7-487)
(NASA-CR-89278) CSCL 06A

The behavior of gelatin when tested with a torsion pendulum is examined with emphasis on the properties of gelatin after being subjected to cryogenic temperature ranges. Studies were focused on providing protein films of different thickness derived from various gelatins. The use of plasticizers, crosslinking agents, and reinforcing fibers in these films at various levels was also considered. Tabulated data are included on gas impermeability and tensile strength determinations. S.P.

N67-38812*# Stanford Research Inst., Menlo Park, Calif. Life Sciences Research.

DIRECT INNERVATION OF CAPILLARY ENDOTHELIAL CELLS IN THE LAMINA PROPRIA OF THE FERRET STOMACH

R. J. Stephens and C. J. Pfeiffer [1967] 7 p refs Submitted for publication

(Contract NAS2-3559)

(NASA-CR-73139) CFSTI: HC $3.00/MF $0.65 CSCL 06C

An electron microscope study on ferret stomach tissue showed that single neurons were separated from the nerve bundle, surrounded by a basement membrane, and unaccompanied by any Schwann cell cytoplasm. Specialized finger-like projections were observed at the end of the neurons which penetrate the basement membrane of the capillary endothelium and come into membranous contact with the external plasma membrane of the endothelial cells. The neurons making membranous contact with the endothelium are regarded as afferent sensory fibers which possibly respond to stimuli contained in the blood. Since gastric secretion is markedly influenced by hormones produced lower in the digestive tract, these nerve endings may be important in regulating a reflex mechanism responsible for gastric control. Another possibility is that the nerve endings are pressure sensitive and are linked via a reflex to the precapillary sphincters permitting a feedback to the sphincter. R.N.A.

N67-38824*# Minnesota Univ., Minneapolis.

THE BACTERIOLOGY OF CLEAN ROOMS

G. S. Michaelsen, O. R. Ruschmeyer, and D. Vesley Washington, NASA, Oct. 1967 72 p refs

(Grant NsG-643)

(NASA-CR-890) CFSTI: HC $3.00/MF $0.65 CSCL 06M

Work accomplished in three areas of space hardware sterilization is recapitulated: (1) microbiological surveys of industrial clean rooms, (2) hand contact contamination experiments, and (3) evaluation of a vertical laminar flow room. The clean room study focused on four conventional industrial clean rooms selected on the basis of existing contamination controls. Ambient airborne contamination levels, surface contamination on work benches, and fallout of contaminants onto stainless steel strips left in the work area for periods up to 21 weeks were investigated. Heat resistant isolates from these strips were later identified and studied for relative resistance to dry heat. Hand contact contamination experiments included investigation of the effect of composition of materials on retention and survival of contaminants, die off of contaminants on handled strips of various materials, and heat resistance studies of contaminants on handled strips. Design and operation of the vertical laminar flow room are described. Extensive tables, charts, and graphs based on the investigative work are included. E.C.

N67-38865*# Stanford Research Inst., Menlo Park, Calif. Life Sciences Div.

ULTRASTRUCTURAL CHANGES OF THE PARIETAL CELL IN THE FERRET GASTRIC MUCOSA INDUCED BY PYLORUS-LIGATION AND GLUCOCORTICOID ADMINISTRATION

C. J. Pfeiffer and R. J. Stephens [1967] 19 p refs Submitted for publication

(Contract NAS2-3559)

(NASA-CR-73138) CSCL 06C

The study was performed on 40 female adult ferrets, maintained on a diet of canned dog food. It was found that pylorus-ligation for 48 hours causes the formation of numerous concentrically arranged smooth membranes within the cytoplasm of the parietal cell. These inclusions are comprised of one to five or more membranes which contain a small amount of cytoplasm and free ribosomes. Mitochondria are widely separated in comparison to the normal parietal cell, and the secretory canals are less extensive and "collapsed." Glucocorticoid administration brings about an additional alteration in the dense bodies of the parietal cell. An electron lucid area develops within the dense body and increases in size until it fills much of the volume of the organelle. The diameter of the dense bodies increases two- to three-fold and their number is also increased. Chief cells are apparently unaffected by these treatments. Author

N67-38998 Joint Publications Research Service, Washington, D. C.

POSSIBILITIES AND PROSPECTS OF THE USE OF HYPOTHERMIA IN THE EXPLORATION OF SPACE

P. V. Byeloshyts'kyy et al 21 Sep. 1967 12 p refs Transl. into ENGLISH from Fizol. Zh., Akad. Nauk Ukr. RSR (Kiev), v. XIII, no. 4, 1967 p 490–495

(JPRS-42709; TT-67-33336)

Laboratory investigations on the effects of hypothermia on animals are reported. In the first series of tests, a method of combined air cooling and contact cooling was used, and the test animals were subjected to hypoxia, acceleration, decompression, and irradiation. The changes in physiological reactions were measured and are discussed. It was found that the configuration of the ECG was changed significantly. The protective role of hypothermia was most evident in connection with decompression, but was also established for acceleration and irradiation. Hypothermy resulted in ill effects in direct proportion to intensity and duration. A second series of tests were conducted to determine the relationship of hypothermized rats with carbon dioxide and injections of aminazine. It was found that prolonged hypothermia remains hazardous. Finally, squirrels (*Citellus citillus*) and marmots were released at high altitudes in the Caucasus where conditions are severe and food is scant, and were found to adapt well. It is concluded that aspects of hibernation can be utilized in space exploration. N.E.N.

N67-39005 Joint Publications Research Service, Washington, D. C.

SPACE BIOLOGY AND MEDICINE, VOLUME 1, NO. 2, 1967

18 Sep. 1967 151 p refs Transl. into ENGLISH of Kosmich. Biol. i Med. (Moscow), v. 1, no. 2, 1967 p 1–88

(JPRS-42635; TT-67-33263) CFSTI: $3.00

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8. STUDY OF THE BIOLOGICAL VALUE OF PLANT PROTEINS IN RELATION TO THEIR USE IN A CLOSED LIFE-SUPPORT SYSTEM N. S. Klyushkina, V. I. Fofanov, and I. T. Troitskaya p 57–64 refs (See N67-39013 23-04)

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10. ON THE IMPROVEMENT OF SOME POLYVINYL CHLORIDE POLYMERS AND DECREASE OF THEIR TOXICITY G. M. Gorban and V. D. Yablochkin p 72–79 refs (See N67-39015 23-04)

11. EXTREMAL FACTORS OF LONG-TERM SPACE FLIGHT AND HEALTH REQUIREMENTS FOR SPACECRAFT CREWS P. V. Buyanov and V. G. Terent'yev p 80–83 refs (See N67-39016 23-04)

12. STUDY OF THE WORK AND REST CYCLES OF TEST SUBJECTS EXPOSED TO RELATIVE ISOLATION N. N. Gurovskiy, B. A. Dushkov, and F. P. Kosmolinskiy p 84–89 refs (See N67-39017 23-04)

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16. CHANGE IN WATER-SALT METABOLISM DURING 62-DAY HYPOKINESIA Ye. N. Biryukov, L. I. Kakurin, G. I. Kozyrevskaya, Yu. S. Kiloskova, Z. P. Payek et al p 111–117 refs (See N67-39021 23-04)

17. THE EFFECT OF VIBRATION AND NOISE ON THE MENTAL FACULTY OF MAN UNDER TIME STRESS K. K. Ioseliani p 118–129 refs (See N67-39022 23-04)

N67-39006 Joint Publications Research Service, Washington, D. C.

RADIATION AND SPACE FLIGHT

Yu. G. Grigor'yev, Ye. Ye. Kovalev, and V. N. Pravetskiy *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 1–6 (See N67-39005 23-04)

A brief discussion is presented of the problems connected with developing a spacecraft radiation protection system and its associated ground support equipment. Basic objectives of such a system are outlined, along with the various instrumentation requirements. C.T.C.

N67-39007 Joint Publications Research Service, Washington, D. C.

PROBLEMS OF AUTOMATION OF OPERATIVE MEDICAL CONTROL IN SPACE FLIGHT

B. B. Yegorov, A. D. Yegorov, A. A. Kiselev, and I. S. Shadrintsev *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 7–18 refs (See N67-39005 23-04)

Problems of the automation of an operative medical control with the use of onboard and ground computers are discussed. A diagram of automation is suggested which involves a comparison of confidence sets for the physiological indices recorded in flight and during simulation. Equations are given for models of changes in physiological indices involving various flight factors. Application of analytical methods (variance, regression, and covariance analyses) makes it possible to determine changes in physiological indices and detect the factor or factors responsible for the changes. Author

N67-39008 Joint Publications Research Service, Washington, D. C.

WAYS TO DEVELOP SPACE PSYCHOLOGY

S. S. Alyakrinskiy *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 19–30 refs (See N67-39005 23-04)

The problems, methods, and principles inherent in the development of space psychology are briefly discussed. Consideration is given to such areas as man's psychic work capacity, the status of his cognitive functions and emotional-pain sphere, and his general and professional behavior. Weightlessness is cited as the most specific space flight factor, and the effect of this factor on the human body as a whole and on man's psyche in particular is discussed. C.T.C.

N67-39009 Joint Publications Research Service, Washington, D. C.

STUDY OF THE CUMULATIVE EFFECT OF IMPACT ACCELERATIONS

S. A. Gozulov, N. P. Morozova, and V. A. Elivanov *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 31–37 refs (See N67-39005 23-04)

Experiments on rats were performed to study the cumulative effect of impact accelerations of 600 G revealed at postmortem examinations. The accelerations were applied at various intervals and subcritical landing velocities. The cumulative lesions resulting from repeated exposures at one hour intervals were detected as the primary lesion of the lungs similarly to the effect of a single exposure at supercritical velocities. Lesions developed after a comparatively small number of repeated exposures (3 to 5) for a wide range of subcritical velocities (7 to 4–5 m/sec). The aftereffect period covers over 24 hours and is related to reactive changes in individual organs. Author

N67-39010 Joint Publications Research Service, Washington, D. C.

CERTAIN ASPECTS CONCERNING OXYGEN METABOLISM OF THE BODY EXPOSED TO PROLONGED ACCELERATIONS

Ye. I. Sorokina *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 38–43 refs (See N67-39005 23-04)

Changes in oxygen metabolism of muscular and brain tissues of animals exposed to prolonged transverse accelerations (oxygen tension and redox potential) are described. The paper also discusses the total oxygen consumption and body temperature under the same conditions. A many-faceted approach to the processes studied allows one to establish new regularities in oxygen metabolism of muscular and brain tissues. Their evaluation helps to understand the role of the changes in tolerance of the body for accelerations on the whole. Author

N67-39011 Joint Publications Research Service, Washington, D. C.

EFFECT OF HYPOXIA ON THE CELLULAR AND HUMORAL IMMUNITY OF MICE

A. S. Kaplanskiy, G. N. Dumova, and N. A. Roshchina *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 44–51 refs (See N67-39005 23-04)

The effect of hypoxia on the protective mechanisms of the animal body was studied on mice exposed to 378 mm Hg for 20 days. Hypoxia was shown to increase the animal sensitivity to bacterial infection (S. typhi) and to inhibit cellular immunity (the phagocytic activity of neutrophils and macrophages decreased). The production of antibodies and the development of hyperplasia of the cell plasma in lymph nodes were not disturbed at the stipulated atmospheric pressure. Hypoxia led to hypoplasia of the lymphoid tissue, most of the lymphocytic cells disappearing. Author

N67-39012 Joint Publications Research Service, Washington, D. C.

ON THE OBJECTIVE EVALUATION OF BODY REACTIVITY

L. Novak *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 52–56 refs (See N67-39005 23-04)

The response of the body to applied stimuli usually is manifested in metabolic changes. However, the objective evaluation of body reactivity has been given too little attention. The scatter of physiological parameters often is very great, thus making impossible an adequate evaluation of the small difference in the reaction of test subjects. A new method for objective evaluation of body metabolism has been developed. The method is based on a comparison of the measured value and the value computed for a biophysical model of the investigated function. The biophysical model is so constructed as to include the factors which may affect the value of the measured function. The observed difference between the computed and measured values reflects the changes in the regulatory mechanisms of the test subject because changes caused by other factors are involved in the computed value of the biophysical model. Author

N67-39013# Joint Publications Research Service, Washington, D. C.

STUDY OF THE BIOLOGICAL VALUE OF PLANT PROTEINS IN RELATION TO THEIR USE IN A CLOSED LIFE-SUPPORT SYSTEM

N. S. Klyushkina, V. I. Fofanov, and I. T. Troitskaya *In its* Space and Med., Vol. 1, No. 2 18 Sep. 1967 p 57–64 refs (See N67-39005 23-04)

The effect of diets including proteins of unicellular green algae or soybeans as the only protein source upon the animal body was studied on two generations of white rats. The proteins of the algae had a quite high biological value in comparison with those of a casein diet. The progeny of test animals appeared to be more viable than those of the control rats. The biological value of soybean proteins was considerably lower than that of algae. Author

N67-39014 Joint Publications Research Service, Washington, D. C.

PHYSIOLOGICAL REGENERATION OF THE EPITHELIUM OF THE CORNEA AND INTESTINE UNDER CONDITIONS OF FRACTIONAL IRRADIATION BY FISSION NEUTRONS

V. M. Mastryukova and A. D. Strzhizhovskiy *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 65–71 refs (See N67-39005 23-04)

A study was carried out to determine the mitotic index and content of chromosomal aberrations in the epithelial cells of mice exposed to fractional irradiation by fission neutrons with doses of 50, 125 and 50 rad/week. Under these conditions compensatory processes increasing the tissue resistance to further irradiations developed in the epithelium of the cornea and intestines. This eliminated an increasing damage of mitotic activity and the genetic structures of cells. Therefore, the tissues developed an equilibrium state whose characteristics depended on the dose rate. Author

N67-39015 Joint Publications Research Service, Washington, D. C.

ON THE IMPROVEMENT OF SOME POLYVINYL CHLORIDE POLYMERS AND DECREASE OF THEIR TOXICITY

G. M. Gorban' and V. D. Yablochkin *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 72–79 refs (See N67-39005 23-04)

Polyvinyl chloride materials used to insulate electric wires in spaceship cabins are a source of contamination of the closed atmosphere with different toxic compounds, such as carbon monoxide, carbohydrates, hydrogen chloride, dibutyl phthalate, aldehydes, and fatty acids. A method was developed for reducing the release of gas by polyvinyl chloride tapes with a 50% urea solution. The reduction of contamination by the treated samples was 100%. The treatment completely eliminated carbohydrates, hydrogen chloride, and fatty acid and significantly reduced the concentrations of carbon monoxide and aldehydes, their levels attaining the maximum admissible concentrations of the substances in atmospheric air. The method does not impair the insulating and mechanical properties of polyvinyl chloride tapes and films. Author

N67-39016 Joint Publications Research Service, Washington, D. C.

EXTREMAL FACTORS OF LONG-TERM SPACE FLIGHT AND HEALTH REQUIREMENTS FOR SPACECRAFT CREWS

P. V. Buyanov and V. G. Terent'yev *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 80–83 refs (See N67-39005 23-04)

Medical selection of spacecraft crews for long-duration space missions is discussed. In view of individual differences in functional limits and tolerance to flight factors, it is suggested to base physical aptitude requirements for candidates on the effect of environmental space flight factors upon the human organism and its tolerance limits. Positive selection is predicated on satisfactory resistance to space-simulation tests (acceleration, physical stress, oxygen starvation, orthostatic tests). Author

N67-39017 Joint Publications Research Service, Washington, D. C.

STUDY OF THE WORK AND REST CYCLES OF TEST SUBJECTS EXPOSED TO RELATIVE ISOLATION

N. N. Gurovskiy, B. A. Dushkov, and F. P. Kosmolinskiy *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 84–89 refs (See N67-39005 23-04)

Results of two 15-day experiments on three test subjects in a sealed chamber, with 24- and 18-hour rest and work cycles, are given. The 18-hour cycle had a greater effect on psychic functions, cardiovascular system, and nervous and muscular activity, and caused more pronounced biochemical changes, indicating the development of nervous and emotional stress. Objective and subjective observations on reaction of the organism to the two cycles are tabulated and plotted. Author

N67-39018 Joint Publications Research Service, Washington, D. C.

STUDY OF SLEEP CHARACTERISTICS UNDER CONDITIONS OF SIMULATED MANNED SPACE FLIGHT

V. I. Myasnikov *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 90–96 refs (See N67-39005 23-04)

To determine factors for protecting spacecraft crews on long-duration missions from environmental hazards and physiological stress, characteristics of sleep patterns in their relation to adaptation and resistance of the organism, were studied. Data are given on reactions to protracted exposure to noise, angular acceleration, and isolation in their effect on sleep. Impairment of sleep included difficult wake-sleep transition, somnolefulness, etc. Correlation of sleep with functional changes is demonstrated with respect to motion sickness and impaired acoustic adaptation. The significance of differential diagnosis of somnolent, precollapsoid, and fatigue states is emphasized. Author

N67-39019 Joint Publications Research Service, Washington, D. C.

CHANGE IN MOVEMENT COORDINATION IN MAN AFTER PROLONGED CONFINEMENT IN A SMALL CHAMBER

B. A. Dushkov *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 97–105 refs (See N67-39005 23-04)

Biodynamic structures of a complex highly automatized act (walking) and specially chosen movements were studied prior to, during, and following 17- and 19-day chamber experiments. Prolonged hypodynamia was shown to disturb the cyclic interaction of structures involved in the motor act and to impair the coordination of biodynamic elements of the neuromotor apparatus in active poses. When developing physical exercises for peculiar conditions, it is recommended to take into consideration the disorders revealed in the human motor coordination (changes of the tempo and rhythm of the activity, physical efforts, and pose). Author

N67-39020 Joint Publications Research Service, Washington, D. C.

EFFECT OF ACCELERATION AND HYPOKINESIA ON THE FUNCTIONAL STATE OF THE STOMACH

P. I. Yegorov, K. V. Smirnov, M. M. Korotayev, and M. V. Lukasheva *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 106–110 refs (See N67-39005 23-04)

The experiments were performed on 5 male test subjects who were twice exposed to chest-to-back accelerations of 11.9–14.5 G with an interval of 4–6 days. After the exposures the test subjects remained in the state of hypokinesia for 2 months. Then they were again exposed to accelerations of 11–16 G. The exposure to accelerations inhibited the secretory and enzyme-forming gastric functions. The acidity of the intestinal juice showed a tendency to increase. Hypokinesia conditions produced further inhibition of the glandular apparatus of the stomach. Author

N67-39021 Joint Publications Research Service, Washington, D. C.

CHANGE IN WATER–SALT METABOLISM DURING 62-DAY HYPOKINESIA

Ye. N. Biryukov, L. I. Kakurin, G. I. Kozyrevskaya, Yu. S. Koloskova, Z. P. Payek et al *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 111–117 refs (See N67-39005 23-04)

The water–salt metabolism was studied on 6 healthy young men in a 62-day bed-rest experiment. Prior to the experiment they were exposed to accelerations of 13 to 15 g. The diet consumed provided 3000 to 3500 cal/day. The amount of water consumed and urine excreted as well as the diuresis rate were investigated. The electrolytic composition of the blood, urine, and feces was determined. The 62-day bed rest resulted in a decrease of water consumption, a change of the diuresis rate, and a shift of the electrolytic composition of urine and feces. The changes were of a phasic character. Two periods can be distinguished in the dynamics of water–salt metabolism: the stage of reconstruction covering 3 to 4 weeks and that of a relative stabilization of metabolism at the level adequate to the new conditions. Peculiarities of the shifts revealed in water–salt metabolism indicate the development of dehydration and decalcification. Author

N67-39022 Joint Publications Research Service, Washington, D. C.

THE EFFECT OF VIBRATION AND NOISE ON THE MENTAL FACULTY OF MAN UNDER TIME STRESS

K. K. Ioseliani *In its* Space Biol. and Med., Vol. 1, No. 2 18 Sep. 1967 p 118–129 refs (See N67-39005 23-04)

The effect of vibration and noise on the mental capacity of man under time stress was studied on 60 examinees in the age group of 25–45 years. Prior to, during, and upon termination of the vibration effects the examinees did addition and subtraction of numbers presented at varying speeds by following the procédure of "continuous counting at a given rate". Investigations demonstrated that the influence of total vertical vibrations at a frequency of 70 cycles per second and an amplitude of 0.4 mm reduces on the average as much as 1.5–2 times the qualitative accomplishment of the experimental task. The effect of noise at 90 decibels cuts the qualitative accomplishment of the task on the average in half. The deepest and most persistent reduction of the mental efficiency is caused by action of a complex irritant—"vibration and noise". The reduction of mental efficiency is greater, the greater the time stress. Author

N67-39027# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.

ADAPTATION TO VESTIBULAR DISORIENTATION. VII: SPECIAL EFFECTS OF BRIEF PERIODS OF VISUAL FIXATION ON NYSTAGMUS AND SENSATIONS OF TURNING

William E. Collins May 1967 22 p refs

(AM-67-12)

The influences of disorientation experience and brief periods of visual still fixation were examined in exposing figure skaters and ordinary subjects to various rates of angular acceleration. Both nystagmic eye movements and sensations of turning were recorded. Skaters produced significantly less primary slow-phase eye displacement than did non-skaters, but the groups did not differ in number of eye movements nor in duration of nystagmus. Introduction of the visual still-fixation period significantly shortened primary nystagmus and produced an accentuated secondary nystagmus for both groups. The term "habituation" (a dropping out of responses), used to define the effects of repeated vestibular stimulation, does not appear to describe completely the active process of change evidenced in the nystagmic tracings presented in this and other studies. Durations of turning sensations were shorter for skaters than non-skaters. For both groups the period of room illumination, allowing subjects actively to fixate on stationary visual objects, significantly shortened or abruptly terminated the subjective reaction. Author

N67-39033*# George Washington Univ., Washington, D. C.

QUARTERLY REPORT, JULY 1–SEPTEMBER 30, 1967

30 Sep. 1967 325 p refs

(Contract NSR-09-010-027)

(NASA-CR-89313) CSCL 06C

This report concerns the Biological Sciences Communication Project and contains the following: (1) a section on planetary quarantine which briefly summarizes current activities and lists a reference bibliography on sterilization techniques; (2) a synopsis of activities in bioscience communications followed by contractual listings of publications supported by the Bioscience Program and covering environmental biology, exobiology, and physical biology; (3) a selected bibliography on radiobiology covering the years 1959–1967; (4) a monograph series outline and author commitments on works dealing with space biology and medicine; (5) a summary of the biosatellite program and news items on COSPAR, both as presented in No. 15 of the publication *Bioscience Capsule*; and (6) mailing lists and correspondence regarding the program. K.W.

N67-39083# General Electric Co., Philadelphia, Pa. Missile and Space Div.

EXISTENCE THEOREMS FOR A NONLINEAR PARTIAL DIFFERENTIAL EQUATION OF VISCOUS, INCOMPRESSIBLE FLOW

Alan Ross Elcrat Aug. 1967 50 p refs (R67SD43)

An existence theorem is proven for a nonlinear partial differential equation for the velocity in time dependent flow of a viscous incompressible fluid through a tube of compliant material. The flow problem is meant to represent the flow of blood in a large relatively straight channel. Existence is shown by dealing with a problem in a space–time region containing the original one that implies the desired existence for the original problem. The problem in the larger region is dealt with by putting it in a setting in which the differential operator involved maps one Banach space into another continuously and is twice Frechet differentiable. Author

N67-39097 Joint Publications Research Service, Washington, D. C.

SPACE BIOLOGY AND MEDICINE, VOLUME I, NO. 3, 1967

22 Sep. 1967 184 p refs Transl. into ENGLISH of Kosmich. Biol. i Med. (Moscow), v. 1, no. 3, 1967 p 1–94 (JPRS-42730; TT-67-33357) CFSTI: $3.00

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19. APPLICATION OF THE MONOSYNAPTIC H-REFLEX IN RECORDING THE EFFECTS OF ELECTRICAL STIMULATION OF THE HUMAN VESTIBULAR APPARATUS Ye. M. Kots and V. A. Mart'yanov p 128–135 refs (See N67-39116 23-04)

N67-39098 Joint Publications Research Service, Washington, D. C.

ON THE PREHISTORY OF DEVELOPMENT OF SPACE BIOLOGY AND MEDICINE

I. M. Khazen *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 1–8 refs (See N67-39097 23-04)

A brief review is presented of the development of space biology and medicine in Russia. Some of the significant accomplishments during this development are cited. C.T.C.

N67-39099 Joint Publications Research Service, Washington, D. C.

ON THE NUTRITION PROBLEM DURING MANNED SPACE FLIGHTS

V. P. Bychkov *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 9–20 refs (See N67-39097 23-04)

In space missions with a duration up to 30 days the crew can use ordinary liquid, semisolid (or pureed), or solid foods. The expendables (oxygen, water, food) necessary for the life support system are stored aboard the spacecraft. During space flights of a longer duration the regeneration of water is anticipated. As a result, dehydrated foods should be taken along. In space missions of a far greater duration (over six months) the crew can be provided with food through its regeneration, storage of dehydrated products, or various combinations of the two methods. Author

N67-39100 Joint Publications Research Service, Washington, D. C.

ON THE PROBLEM OF PHARMACOLOGY IN SPACE MEDICINE

V. Ye. Belay, P. V. Vasil'yev, and G. D. Glod *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 21–30 refs (See N67-39097 23-04)

On the basis of data in the literature and their own findings the authors discuss the application of pharmacology in space studies. The data on the effect of various pharmacoactivate (narcotic, analeptic, cardiovascular drugs) on the animal tolerance to prolonged transverse accelerations are presented. It was found that there is a changed reactivity of the human body to some drugs induced by long-term exposure to accelerations and changed atmospheric conditions. The main tasks and trends in the development of space pharmacology are reviewed. Author

N67-39101 Joint Publications Research Service, Washington, D. C.

ON THE MECHANISM OF THE DEVELOPMENT OF RESPONSES AND ADAPTATION TO HYPOXIA

G. I. Gurvich and N. Z. Epshteyn *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 31–36 refs (See N67-39097 23-04)

The objective of this paper is a study of the mechanisms underlying the development of adaptation to oxygen deficiency in animals. The reticular formation was investigated for this purpose. Experiments were carried out in three series. In the experiments of the first two series aminasine was used which produced a blocking effect on the reticular formation. The experiments performed on rats and rabbits showed that their resistance to oxygen starvation increased through adaptation to chronic hypoxia and decreased in comparison with the control. In the experiments of the third series the reticular formation of the paws and epidermis of the rates underwent an electrolytic destruction. This resulted in a better adaptation of the animals to prolonged hypoxia. The experimental data obtained in this way indicate that the reticular formation participates in the development of both response and adaptation to hypoxia. However, different parts of the reticular formation produce a different effect. Author

N67-39102 Joint Publications Research Service, Washington, D. C.

STUDY OF THE DEVELOPMENT OF CHLORELLA DURING SPACE FLIGHT

V. A. Shevchenko, I. S. Sakovich, L. K. Meshcheryakova, and M. G. Petrovnin *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 37–41 refs (See N67-39097 23-04)

This paper presents data on the viability and mutations of colonies of Chlorella detected after flight aboard the Kosmos 109 and Kosmos 110 satellites. The flight conditions produced no noticeable effect on the development of Chlorella. Author

N67-39103 Joint Publications Research Service, Washington, D. C.

SPERMATOGENESIS OF THE DOGS UGOLYOK AND VETEROK AFTER THEIR FLIGHT ON BOARD THE SATELLITE KOSMOS 110

N. L. Fedorova *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 42–47 refs (See N67-39097 23-04)

A study was carried out to determine the state of spermatogenesis and reproductive ability of the dogs Ugolyok and Veterok after their 22-day flight on board the biological satellite Kosmos 110. The cumulative effect of space flight factors caused transient changes of the ejaculate. The animals produced a normal progeny, whose development is normal. Author

N67-39104 Joint Publications Research Service, Washington, D. C.

EFFECT OF EXTERORECEPTION ON THE MOTOR REACTION OF PIGEONS EXPOSED TO BRIEF WEIGHTLESSNESS

Z. Novotny *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 48–55 refs (See N67-39097 23-04)

Twelve healthy pigeons were used in a study of the effect of increased and decreased exteroreception on the reactivity of their motor analyzer. The experiments were carried out during brief weightlessness, visual orientation being retained or excluded. A similar study was made on eight labyrinthectomized birds. The test pigeons were placed in a vertically swinging cage. Its arrest in an upper position produced a brief decrease of gravity. The threshold of the motor reaction of the wings during weightlessness was determined. Author

N67-39105 Joint Publications Research Service, Washington, D. C.

DEPENDENCE OF ALTITUDE TOLERANCE OF ANIMALS ON THE STATE OF PHOSPHORYLATION PROCESSES

T. A. Allik and L. I. Karpova *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 56–58 refs (See N67-39097 23-04)

Experiments were carried out on rats to study the effect of hypokinesia on their oxygen consumption at rest, level of amytal-sensitive and amytal-resistant respiration in vivo, activity, and altitude tolerance. The effect of a sodium amytal injection on the activity and altitude tolerance was investigated in rats exposed to 6-week hypokinesia and control animals. The exposure decreased oxygen consumption from 159.0±6.7 to 94.4±23.3 ml per 100 g of body weight per hour. The part of the amytal-sensitive respiration taken for phosphorylating respiration diminished from 56.8±2.16% to 23.7±2.0%. The activity and altitude tolerance fell in parallel with a decrease of the phosphorylating respiration. An amytal injection made 3–4 days before an exposure to extreme factors (maximum activity and acute hypoxia) elevated both the activity and altitude tolerance. The authors believe that maximum activity and altitude tolerance of an animal organism are in a direct relation to the power of enzymic systems of phosphorylating oxidation. Author

N67-39106 Joint Publications Research Service, Washington, D. C.

MEASUREMENT OF TISSUE DOSES OF COSMIC RADIATION BY NUCLEAR EMULSIONS

K. S. Bogomolov, Ya. M. Veprik, M. Yu. Debardeyev, Ye. Ye. Kovalev, E. G. Litvinova et al *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 59–65 refs (See N67-39097 23-04)

Methods for measuring the tissue dose of ionizing radiations with the aid of nuclear emulsions are discussed. Emulsions differing in their sensitivity, with different physical development techniques, were used. Measurements made aboard "Kosmos" satellites are described. Author

N67-39107 Joint Publications Research Service, Washington, D. C.

NITROGEN METABOLISM IN ANIMALS EXPOSED TO HYPOKINESIA

I. V. Fedorov and L. A. Grishanina *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 66–72 refs (See N67-39097 23-04)

Changes of nitrogen metabolism were studied in rats exposed to experimental hypokinesia. Under these conditions the animals exhibited a sharp increase of total nitrogen, urea, creatinine, and phosphorus released with the urine, as well as a stable negative equilibrium of nitrogen. Author

N67-39108 Joint Publications Research Service, Washington, D. C.

EXPERIMENTAL STUDY OF MASS METABOLISM IN CLOSED LIFE-SUPPORT SYSTEMS

A. P. Tereshchenko *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 73–79 refs (See N67-39097 23-04)

Peculiarities of the cycle of substances in life-support systems designed for long space flights are discussed. A method for its experimental study on the basis of mass and energy metabolism in system components is proposed. Author

N67-39109 Joint Publications Research Service, Washington, D. C.

ON THE SENSOMOTOR COORDINATION OF MAN DURING WEIGHTLESSNESS

N. N. Gurovskiy and M. A. Cherepakhin *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 80–84 refs (See N67-39097 23-04)

This paper presents the results of a study of the motor coordination of man in a state of weightlessness. The study is concerned with two parameters: accuracy and duration of performance of motions. Short-term weightlessness (18 to 25 sec) was created during a jet flight in a Keplerian trajectory. The accuracy of movements and time spent in their performance were very similar during both the state of weightlessness and in horizontal flight. The differences noted were without statistical significance. Author

N67-39110 Joint Publications Research Service, Washington, D. C.

POSITION OF PILOT'S HANDS AND FEET ON COCKPIT CONTROLS DURING LOSS OF CONSCIOUSNESS DURING SIMULATED FLIGHTS

J. J. Dvorak, V. V. Cerny, S. S. Cirek, B. F. Filsakova, B. I. Grubyseva et al *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 85–88 ref (See N67-39097 23-04)

Simulated flights of nine test subjects revealed that despite fainting caused by an acute hypoxia they correctly maintained altitude control in 92% of the cases, engine power control in 54% of the cases, and direction control in 60% of the cases. It appears that during an aircraft accident a pilot can keep his hands and feet on the cockpit controls despite fainting. Author

N67-39111 Joint Publications Research Service, Washington, D. C.

THE SCANNING ACTIVITY OF A MAN OPERATOR EXPOSED TO SPACE FLIGHT FACTORS

Ye. S. Zav'yalov and S. G. Mel'nik *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 89–96 refs (See N67-39097 23-04)

A 10-day period of hypokinesia of a man operator resulted in a deterioration of his compensatory scanning. His control habits were restored by daily training by the third day after exposure to hypokinesia. The relationship between the control habits and the level of hypoxia and hypercapnia was determined. Scanning habits were significantly impaired when the man operator was exposed to an atmosphere containing 8.2% O_2. Breathing air with a CO_2 content of 7.2–8.6% resulted in a transient deterioration of his scanning activity. At a CO_2 concentration of 9–9.2% the activity remained impaired throughout the hypercapnia effect. Author

N67-39112 Joint Publications Research Service, Washington, D. C.

BRAIN HEMODYNAMICS DURING PROLONGED HYPOKINESIA

G. I. Gurvich and G. D. Yefimenko *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 97–102 (See N67-39097 23-04)

The rheoencephalographic technique was applied to a study of cerebral hemodynamics of four test subjects exposed to prolonged (up to 75 days) hypokinesia. Examinations were made prior to, during, and following the bed rest experiment. Observations also were made with the aid of orthostatic tests performed at the end of bed rest. The studies revealed a phasic pattern of changes of cerebral hemodynamics and their correlation with changes of higher nervous activity. In addition, the experiments revealed that the rheoencephalographic technique can be used for early diagnosis of intolerance to prolonged hypokinesia and precollaptoid states during orthostatic tests. Author

N67-39113 Joint Publications Research Service, Washington, D. C.

FUNCTIONAL STATE OF THE HUMAN AUDITORY ANALYZER IN AN EXPERIMENT WITH TWO-MONTH HYPOKINESIA

I. Ya. Vskovlevs and E. I. Matsnev *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 104–110 refs (See N67-39097 23-04)

A study of the functional state of the human acoustic analyzer was carried out during a two-month exposure of test subjects to hypokinesia. The test subjects were six healthy men aged 22–36. The effect of hypokinesia was brought about by strict bed rest. The experiments revealed transient functional impairments of hearing which resulted in an increase of the thresholds from 15 to 34 db. The changes may be attributed to disturbances of the central nervous system and circulation causing hemostasis in the inner ear. Author

N67-39114 Joint Publications Research Service, Washington, D. C.

ON THE DIFFERENTIAL DIAGNOSIS OF SOMNOLENT AND PRECOLLAPTOID STATES IN MAN

O. P. Kozerenko and V. I. Myasnikov *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 111–120 refs (See N67-39097 23-04)

Experiments were carried out on healthy men to study somnolent and precollaptoid (collaptoid) states when falling asleep and during prolonged standing states. General regularities of the dynamics of the states indicated that they were intermediate processes (end functional effect, undulatory pattern of changes of physiological parameters, appearance of functional disturbances at different times). An electrophysiological analysis of the investigated processes demonstrated that the most informative symptom of the somnolent state was a change of the electroencephalographic frequency and amplitude and that of the precollaptoid state was a cardiovascular change (pulse rate and arterial pressure). The problem is related to medical control of the health of a space crew. Author

N67-39115 Joint Publications Research Service, Washington, D. C.

SOME INDICES OF THE HUMAN NATURAL RESISTANCE TO THE DIETARY REPLACEMENT OF ANIMAL PROTEIN BY CHLORELLA PROTEINS

V. I. Fofanov, M. I. Kozar', and N. N. Dobronravova *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 121–127 refs (See N67-39097 23-04)

This paper presents the results of experiments carried out on five men aged 24–30 who for 30 days consumed a diet in which animal proteins were replaced by Chlorella proteins. The activity of lysozyme in the saliva and blood serum was studied. The titer of the complement and the serum bactericidal activity were investigated in relation to E. coli. The diet produced an inhibiting effect on the activity of lysozyme in the saliva and blood serum. Author

N67-39116 Joint Publications Research Service, Washington, D. C.

APPLICATION OF THE MONOSYNAPTIC H-REFLEX IN RECORDING THE EFFECTS OF ELECTRICAL STIMULATION OF THE HUMAN VESTIBULAR APPARATUS

Ya. M. Kots and V. A. Mart'yanov *In its* Space Biol. and Med., Vol. 1, No. 3 22 Sep. 1967 p 128–135 refs (See N67-39097 23-04)

An evaluation of the reflex excitability of spinal motoneurons (H-reflex) was used in a quantitative control of the effect of

electrical stimulation of the vestibular apparatus in man. An increase of the H-response amplitude of muscles of the calf was observed 20–30 msec following an application of a 1-msec vestibular stimulation. During the subsequent 60–70 msec the amplitude of the H-response grew in proportion to the force and duration of the stimulation. Ipsilateral effects of the vestibular stimulation revealed a lower threshold in comparison with contralateral ones.
Author

N67-39136# Kansas Univ., Lawrence.
STUDIES RELATED TO AN EARLY DETECTION OF TOXIC EFFECTS OF ORGANIC CHEMICALS Final Report, Oct. 1965–31 Aug. 1967
Harbans Lal 31 Aug. 1967 33 p refs
(Contract N00014-66-C0006)
(AD-657252)

Inhalation of methylchloroform containing air in a continuous flow inhalation chamber altered the pharmacological responsiveness of the exposed animal. It decreased the duration of hypnosis induced by hexobarbital or pentobarbital but did not affect the barbital or chloralhydrate hypnosis. There was a significant increase in the hexobarbital oxidase activity of the liver microsomes but the microsomal nitro-reductase was not affected. The pharmacological as well as the biochemical changes were reversible. They were blocked by the pretreatment with ethionine. Intraperitoneal injections of methylchloroform produced effects which were opposite to those produced by its inhalation. The pentobarbital hypnosis was prolonged and the liver hexobarbital oxidase activity was depressed. It is concluded that methylchloroform produced specific changes in the drug metabolising enzyme systems. The nature of these changes were related to the route of administration of this agent.
Author (TAB)

N67-39260# School of Aerospace Medicine, Brooks AFB, Tex. Aerospace Medical Div.
INCIDENCE OF EAR, NOSE, AND THROAT DISEASES IN 400 SPACE AND TEST PILOT CANDIDATES, 1 AUGUST 1963–1 AUGUST 1965
William L. Mitchell, Morgan E. Wing, and Frederick G. Collins
May 1967 22 p refs
(SAM-TR-67-45; AD-657030)

The incidence of past and present ear, nose, and throat diseases derived from comprehensive evaluation of 400 space and test pilot candidates is reported. Comparisons are made between several items of past medical history, findings from physical examinations, and results of specialized examinations. The data presented provide useful information in the medical selection of space pilot candidates and an opportunity to study the results of longitudinal aeromedical screening. Additionally, the possible relationship between asymptomatic ear, nose and throat diseases in flying personnel and such factors as age, flying time, history, and results from examinations is discussed.
Author (TAB)

N67-39316*# National Aeronautics and Space Administration, Washington, D. C.
[PLANT AND ANIMAL LIFE SAFELY RECOVERED FROM BIOSATELLITE II]
14 Sep. 1967 10 p
(NASA News Release-67-239) Available from the Clearinghouse for Scientific and Technical Information CSCL 06F

Findings from a preliminary analysis of Biosatellite II flight effects on a variety of plant and animal species are summarized in a news release. Radiation effects on organisms under weightless conditions, particularly wheat seedlings and pepper plants, are cited. Brief accounts are given based on preliminary examination of Biosatellite II experimental data in following areas: amoeba, frog legs, adult vinegar gnats, vinegar gnat larvae, blue wild flowers, flour beetles, parasitic wasps, orange bread mold, and lysogenic bacteria.
E.C.

N67-39320# Cekmece Nuclear Research Center, Istanbul (Turkey).
CHANGES OF NATURALLY OCCURRING ZINC LOCATION DURING ITS GROWTH, DETECTED HISTOCHEMICALLY
Emine Polar Jan. 1967 33 p refs
(CNAEM-42) CFSTI: HC $3.00/MF $0.65

This investigation was conducted to determine the relationship between zinc and growth of tissues and cells from the early stage of development up to maturation, as well as the probable relationship between zinc and cell division. The work deals with the distribution of dithizone detectable zinc in various cells and tissues of *Vicia faba* from its cotyledon before germination through all phases of its growth up to five internodes. The materials and methods used are described along with details of the observations and results.
R.N.A.

N67-39361*# General Electric Co., Philadelphia, Pa. Missile and Space Div.
A STUDY OF THE COLLECTION AND PRESERVATION OF BIOLOGICAL SPECIMENS DURING SPACE FLIGHT FOR POST-FLIGHT ANALYSIS Final Report
[1967] 219 p refs
(Contract NASw-1562)
(NASA-CR-89336) CFSTI: HC $3.00/MF $0.65 CSCL 06C

Safety and measurement criteria for biological sampling are discussed; and analytical methods employed in blood, urine, and feces and sweat investigations are presented along with a bibliography for each of the categories and a correlation of analytical methods for constituents common to blood and urine. Sampling sites and methods; gas chromatography, mass and infrared spectroscopy, fluorescent antibody technique, and modified conventional analytical techniques; and media and preservation of samples for postflight analysis are considered. Details are included for chemical, refrigeration, freezing, vacuum distillation, adsorption and ion exchange, and lyophilization preservation techniques; and biological aspects of preserving blood, urine, feces and sweat are treated. Collection and handling procedures, the sampling regimen, and the training program are described.
M.W.R.

05 BIOTECHNOLOGY

Includes life support systems, human engineering; protective clothing and equipment; crew training and evaluation, and piloting. For related information see also: 04 Biosciences.

N67-38100# California Univ., Los Angeles. Dept. of Engineering.
PERFORMANCE STUDIES ON THE NOTS-UCLA TRACKING SIMULATOR: AN INVESTIGATION OF OPERATOR PREDICTIVE BEHAVIOR ON TWO-DIMENSIONAL COMPENSATORY TRACKING
Russell L. Smith and John Lyman Jun. 1967 30 p refs
(Contract N123(60530)32857A)
(Rept.-67-32; TR-40; AD-657182)

The experiment assessed the extent to which operators employed predictive behavior on two-dimensional tracking. Two problems were presented: in one, operators were asked to extrapolate an overlearned trajectory upon the disappearance of the target

and in the other, operators tracked one of four possible trajectories with and without pre-test knowledge concerning the specific trajectory that would be presented. No evidence was found which suggested that operators exhibited predictive behavior on the bases of trajectory experience, immediate past history of the target, or expectancies derived from the pre-test trajectory information. The results also indicated that tracking error is largely a function of trajectory pattern, rather than the actual target dynamics (velocity, acceleration), and that error magnification facilitated performance on all patterns. Author (TAB)

N67-38107# California Univ., Los Angeles. Dept. of Engineering.
PERFORMANCE STUDIES ON THE NOTS-UCLA TRACKING SIMULATOR Final Report, Apr. 1963–Jun. 1967
Russell L. Smith and John Lyman Jun. 1967 35 p refs
(Contract N123(60530)32857A)
(Rept.-67-33; TR-41; AD-657184)

The report summarizes the principal findings from a series of human tracking experiments conducted on the high inertia NOTS–UCLA tracking simulator. Emphasis in the series was on displays, controls, multiple sensory cues, trajectory characteristics, and predictive behavior of the human operator. Results from various studies relevant to particular parameters are integrated to provide continuity. Theoretical and practical implication of the data are discussed in relation to design of range tracking systems. Limitations of findings are also discussed and reference is made to areas which appear in greatest need of continued research. Author (TAB)

N67-38177# California State Polytechnic Coll., San Luis Obispo.
DEUTERIUM ISOTOPE STUDIES ON 2,3-DICARBAHEXABORANE (8)
John R. Spielman, Richard Warren, Gary B. Dunks, James E. Scott, Jr., and Thomas Onak 1 Aug. 1967 11 p refs Submitted for publication
(Contract Nonr-3364(00))
(TR-14; AD-657174)

Deuterium exchange at various positions on the C2B4H8 molecule was studied. D2 exchanges with all boron-bonded hydrogen atoms, and B2D6 in the presence of diglyme exchanges only at the 4-, 6-terminal positions. The (CH3)2C2B4H6-DCl exchange, catalyzed by aluminum chloride, occurs at both apex and base terminal positions. C,C-Dideuterio-2,3-dicarbahexaborane(8), D2C2B4H6, was prepared for comparison of the infrared spectrum. Author (TAB)

N67-38180# Washington Univ., Seattle.
THE CONSTANT ERROR IN AMPLITUDE DISCRIMINATION AND THE INTER-STIMULUS INTERVAL: A REEXAMINATION
Don A. Ronken [1966] 94 p refs
(Contract Nonr-477(34))
(PRP-35N; AD-657263)

The constant error or time error observed in psychophysical discrimination experiments has been a source for conjectures about the judgment process, the suggestion being that the nature of the errors indicates something significant about the underlying decision mechanism. The classical experiment for this purpose shows how the constant error or response bias changes as the inter-stimulus interval varies. This relationship is examined for the case of amplitude discrimination by using an XAB paradigm which switches between several amplitude levels randomly from trial to trial. Data from three very experienced observers indicate that with this procedure, variations in the inter-stimulus interval do not affect the response bias, but the discriminability decreases regularly with increasing intervals. A signal detection-type model is developed for the experiment which is used to describe two alternative interpretations for the effect of the inter-stimulus interval. The first interpretation follows the classical fading trace notion, while the second postulates a random walk for the psychological representation of stimulus X. It is shown that neither hypothesis alone is sufficient to account for the discriminability changes that occur with the inter-stimulus interval; effects characteristic to each interpretation appear in the data. Author (TAB)

N67-38192# Aerospace Medical Div. Aerospace Medical Research Labs. (6570th), Wright-Patterson AFB, Ohio.
ATTENUATION CHARACTERISTICS OF EARMUFFS AT LOW AUDIO AND INFRASONIC FREQUENCIES Final Report, Jan. 1966–May 1966
Charles W. Nixon, Harold K. Kille, and L. Keith Kattler (Dayton Univ.) May 1967 24 p refs
(AMRL-TR-67-27; AD-655939)

Sound attenuation and transmission loss characteristics of three different earmuffs models were determined from (1) physical measurements of discrete frequency signals in the range from 1 to 500 Hz inside and outside earmuffs being worn by subjects and (2) psychoacoustical or subjective measurements employing the United States of America Institute of Standards Real Ear Attenuation at Threshold Method. Evaluation of the data showed good correlation between the two measurement methods. Greater attenuation was obtained with the subjective method. It was interpreted to be due primarily to the masking effects at threshold of hearing of physiological noise present under the earcups. Findings show that typical present-day earmuffs provide approximately 10 dB of attentuation in the frequency range from 20 to 100 Hz and very little sound protection below 20 Hz. It is recommended that insert earplugs be used for sound protection in intense low audio frequency and infrasonic sound fields. Good earmuffs in combination with insert earplugs should provide more protection than earplugs alone. Author (TAB)

N67-38244# George Washington Univ., Washington, D. C. Human Resources Research Office.
SOME EFFECTS OF DIFFERENTIAL PRETASK INSTRUCTIONS ON AUDITORY VIGILANCE PERFORMANCE
G. L. Neal Jul. 1967 10 p refs Presented at the Southwestern Psychological Assoc. Meeting, Houston, Tex., Apr. 1967 *Its* Profess. Paper No. 34–67
(Contract DA-44-188-ARO-2)
(AD-656942)

In this study of the evaluation of pretask instruction effects on vigilance performance, the researchers made an assessment of demand characteristics. Subjects were 203 students from University of Oklahoma classes who were given four possible reasons for the experiment: the treatments were called Required Chore, Important Task, Subject Important, and Combined Treatments. It was demonstrated that subject motivation level via pretask instructions can influence the course of the monitors performance, at least in the short run. Author (TAB)

N67-38534# Naval Personnel Research Activity, San Diego, Calif.
AN EXPERIMENT IN BASIC AIRBORNE ELECTRONICS TRAINING. PART III: EFFECT OF REDUCTION IN PREVIOUS TRAINING UPON ABILITY TO LEARN OPERATIONAL EQUIPMENT
Alexander A. Longo and G. Douglas Mayo Mar. 1967 16 p refs
(STB-67-19; AD-656893)

A longitudinal study was made pertaining to whether training time can be reduced in basic airborne radar technician training through judicious revision of the course. The study compared the relative performance of two matched groups of 29 men each on the

basis of their ability to learn a representative item of operational equipment for which the Aviation Electronics Technician (Radar and Radar Navigation System) is responsible. The results indicated that, despite the reduction of the original course from 30 weeks to 22 weeks, graduates of the revised course achieved the objectives of the representative equipment course as well as did graduates of the longer course. Based upon this information in conjunction with the information provided by the two previous reports and certain logical considerations, basic airborne radar technician training was reduced from 30 weeks to 25 weeks. Author (TAB)

N67-38633# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
HEALTH PHYSICS APPLICATIONS OF A THIN SILICON DETECTOR
Eli Yablonovitch Aug. 1967 14 p refs
(AECL-2788) CFSTI: HC$3.00/MF$0.65

A totally depleted, silicon, dE/dx counter (200 microns thick) was tested for use in general purpose dosimetry. The response to α, β, and γ-rays as well as to fast neutrons is presented and the measurements indicate a detector of unusual versatility. Author

N67-38708# CBS Labs., Stamford, Conn.
DEVELOPMENT OF AUDIO TRANSDUCER HELMET ASSEMBLY Quarterly Report, 2 Jan.–31 Mar. 1967
Allan J. Rosenheck and Alfred L. DiMattia Jul. 1967 23 p
(Contract DAAB07-67-C-0204)
(ECOM-0204-1; Rept.-1; AD-656938)

Program objective is the development of an Audio Transducer Helmet Assembly to be used in the Army Aircrewman Helmet. The assembly includes earphones mounted in attenuating earcups along with auxiliary hardware, wiring and ancillary devices. A further goal is development of a miniature moving-coil, noise-cancelling microphone having improved noise-cancellation characteristics. A comprehensive review of previous efforts was performed including evaluation of the enclosure presently used on the APH-5 helmet and a survey of several novel ear enclosure concepts under recent Army contracts--low-frequency-coupled volumes, low-profile ear enclosures, gel-filled cushions, mutual-stiffness-coupled and bellows-coupled enclosures. Evaluation and comparison of these and other methods revealed that low-frequency-coupled volumes or low-profile enclosures, in conjunction with gel-filled cushions, are most feasible for this application. Assessment was made of the space available in the present helmet for enclosures with a goal of avoiding an increase in the external ear-to-ear measurement. Various techniques of mounting the enclosures within the helmet were explored and experiments performed toward optimizing the gel-filled cushion design. Author (TAB)

N67-38724# Washington Univ., Seattle.
MONOCULAR BRIGHTNESS AND FECHNER'S PARADOX
Davida Y. Teller and Eugene Galanter [1966] 18 p refs
(Contract DA-49-193-MD-2713)
(PRP-30A; AD-657331)

Monocular brightness were varied without varying monocular luminances, both by means of simultaneous contrast and by means of changes in the level of dark adaptation. Binocular brightness was shown to change in accord with monocular brightness changes. Author (TAB)

N67-38808*# Martin Co., Baltimore, Md.
ANALYSIS OF CREW PERFORMANCE IN THE APOLLO COMMAND MODULE, PHASE II. VOLUME I
Milton A. Grodsky and David L. Glazer Jan. 1967 99 p refs
(Contract NAS9-5730)
(NASA-CR-65757; ER-14396, Vol. I) CSCL 05H

Results of the Phase II analyses concerned with the evaluation of pilot performance data obtained in a ground-based simulation situation of the Apollo lunar landing mission, are presented. The analyses were designed to obtain statistically verifiable information and factors which relate pertinent aspects of the operational situation to pilot performance. The effects of the following variables were quantitatively studied: (1) checklists, (2) communications blackout periods, (3) control response to changing spacecraft inertia, (4) isometric exercises, (5) diurnal cycle variations, and (6) mission-to-baseline correlates. Pilot performance obtained in five lunar landing simulations were investigated relative to system design and mission parameters of the Apollo Command Module (CM). L.S.

N67-38807*# Hughes Research Labs., Malibu, Calif.
RESEARCH AND DEVELOPMENT PROGRAM FOR RADIATION MEASUREMENTS OF RADIOBIOLOGICAL HAZARDS OF MAN IN SPACE Summary Technical Report, 1 Aug. 1966–31 Jul. 1967
31 Jul. 1967 55 p refs
(Contract NAS2-2366)
(NASA-CR-73146) CFSTI: HC$3.00/MF$0.65 CSCL 06R

Center line depth dose studies were conducted with high energy protons in an effort to develop methods for measuring the radiobiologically significant dosimetric quantities to be used for evaluating radiation hazards associated with manned space flights and for evaluating high energy proton irradiation of tissue cells and whole animals. Frequency distribution data plots for microscopic energy deposition spectra of protons passing through gaseous mixtures of helium and carbon dioxide, through water, and through tissue equivalent plastic, are presented and discussed. L.S.

N67-38814* Martin Co., Baltimore, Md.
ANALYSIS OF CREW PERFORMANCE IN THE APOLLO COMMAND MODULE, PHASE II. VOLUME II: APPENDIX
Oct. 1966 109 p
(Contract NAS9-5730)
(NASA-CR-65758; ER-14396, Vol. II) CSCL 05H

This appendix contains tabulated pilot raw scores on selected flight control parameters, and graphic data on individual pilot isometric performance and diurnal variation of biomedical status by individual pilot. R.N.A.

N67-38840* IIT Research Inst., Chicago, Ill. Technology Center.
POWER DRIVEN ARTICULATED DUMMY Final Report, May 22, 1963–Jul. 31, 1965
J. Slowik 14 Dec. 1965 234 p
(Contract NAS9-1370)
(NASA-CR-65740) CSCL 05E

Details are presented on the dummy, which can simulate human motions, for qualitatively sensing the forces imposed by a space suit. It is hydraulically powered and remotely controlled. The dummy simulates thirty-five basic human motions and can be adjusted to approximate in size the five to ninety-five percentile man. The electrical, hydraulic, and mechanical systems use present state-of-the-art components and techniques. The actuators and control valves for the power supply systems are described, and the electro-hydraulic control system is outlined. Strain gauges were chosen for the torque sensor system. Diagrams of the motion capabilities, circuit diagrams, and mechanical drawings, and parts lists are appended. N.E.N.

N67-38942* Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
SIMULATION STUDY OF THE DRIVER'S CONTROL FOR SUDDEN CHANGES IN PREVIEWED PATH
R. D. Roland and T. B. Sheridan Jun. 1967 58 p refs
(Grants NsG-107; PHS AC-00206)
(NASA-CR-89272; DSR-74920-1) CSCL 05H

Results of three different types of visual automobile driving simulation tests are presented and discussed. The tests consisted of: 1) an abstract spot moving on an oscilloscope, 2) a television picture resulting from a television camera driven by a model car through a model environment, and 3) an actual car driven through a test course. The driver subject in each case was asked to steer his vehicle so that its trajectory would successively coincide with one or more targets which suddenly appeared in his view ahead in pseudorandom positions. Forward velocity was not under the subject's control. The effects of preview time, the effect of target configurations (and their number), and the variability of trajectories for the same target configuration on the response of the subjects were studied. L.S.

N67-38958# Federal Aviation Agency, Oklahoma City, Okla. Office of Aviation Medicine.
ADAPTATION TO VESTIBULAR DISORIENTATION. V: EYE-MOVEMENTS AND SUBJECTIVE TURNING RESPONSES TO TWO DURATIONS OF ANGULAR ACCELERATION
William E. Collins and Fred E. Guedry, Jr. May 1967 21 p refs
(AM-67-6)

Influences of the duration of angular acceleration on turning sensations and on nystagmic eye movements which can blur vision are relevant to understanding vestibular reactions during certain aircraft accelerations. Ocular recordings were obtained from human subjects and cats to $4°/sec^2$ angular accelerations of 8.4 sec and of 36 sec duration. Lateral and vertical canals were stimulated on separate trials with output of both primary and secondary nystagmus greater for the lateral canals. In cats, both lateral- and vertical-canal responses to 36-sec stimuli peaked and then steadily declined after 15–21 sec of angular acceleration. Declines were not apparent in nystagmus of human subjects. In an additional test, humans were given special tasks and cats received d-amphetamine with essentially the same results as described above. Other group differences were noted. Cats consistently demonstrated secondary nystagmus whereas humans did not. After termination of acceleration, primary nystagmus from cats lasted longer and exhibited a greater number of eye movements following 8.4 sec stimuli than following 36 sec stimuli; this consistency was not evident in humans. However, for humans sensations of motion following termination of acceleration were longer for the 8.4 sec stimuli than for 36 sec stimuli. In this regard, nystagmus from cats resembled the subjective reactions of man more than they did the nystagmus of man. Author

N67-39049* Massachusetts Inst. of Tech., Cambridge. Engineering Projects Lab.
A PREVIEW CONTROL MODEL WITH ONE OR TWO FAST TIME SCALE LOOPS
Richard Allen Miller (M.S. Thesis) Aug. 1967 102 p refs
(Grant NsG-107)
(NASA-CR-89264; DSR-70283-4) CSCL 05H

This thesis was concerned with development of a model of the human operator in control situations where the human can view the future input. The modeling technique used either one or two dynamic models of the controlled plant, operating in time scales faster than real time, to produce an estimate of the future response of the plant. This simulated the human's ability to estimate future responses. The preview problem was treated as an optimization problem and was solved analytically via the calculus of variations. It was shown that the use of fast-time predictor models provided a stable method of numerically solving the resultant two point boundary value problem. Additional fast models resulted in better future response estimation with the final system output approaching the optimum. Extensive computer simulations were performed and the results for step and continuous inputs reported. Two human subjects were tested and their average responses matched by the preview control model discussed. For the plants used the match was of good quality. Author

N67-39251*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
DETERMINATION OF TERMINAL STERILIZATION PROCESS PARAMETERS
J. A. Stern and A. R. Hoffman 1 Oct. 1967 13 p refs
(Contract NAS7-100)
(NASA-CR-89233; JPL-TR-32-1191) CFSTI: HC $3.00/MF $0.65 CSCL 06T

The time/temperature effects on the reliability of spacecraft components and assemblies require that the terminal heat sterilizing process for spacecraft be adequate, but minimal. Accordingly, an analytical model was developed to study the effects of various facets of the terminal sterilization process and to establish the relationship which exists between the thermal characteristics of the spacecraft and microbial contamination. A simple geometrical configuration of the spacecraft was assumed. The effects upon the process parameters of times and temperatures of various heating and cooling rates were studied. In addition, various distributions of microbial load were postulated and the processes necessary to achieve sterility of the model spacecraft were determined. These variables, as well as the microbial heat-resistance parameters, are shown to affect significantly the derived process time at any temperature. Author

N67-39317# Japan Atomic Energy Research Inst., Iberaki. Div. of Health Physics and Safety.
ACTIVITIES IN THE DIVISION OF HEALTH PHYSICS AND SAFETY, APRIL 1, 1966–MARCH 31, 1967
S. Sakagishi May 1967 181 p refs In JAPANESE; ENGLISH summary
(JAERI-5016) CFSTI: HC $3.00/MF $0.65

Construction progress and installation of reactor radioisotope facilities is reported. Annual statistics of exposure in existing facilities are given. The frequency of injury and damage to personnel; floor and air contamination; general safety techniques; reactor and laboratory monitoring; counting instrumentation; general administration; and facility maintenance, are discussed. L.S.

N67-39349* Martin Co., Baltimore, Md.
ANALYSIS OF CREW PERFORMANCE IN THE APOLLO COMMAND MODULE. PHASE I. VOLUME II: APPENDIX
Jun. 1966 163 p
(Contract NAS9-5730)
(NASA-CR-65756; ER-14264, Vol. II) CSCL 05H

This appendix to the Apollo crew performance analysis contains a crew checklist of various activities to be performed during the Apollo mission, an etiology of crew errors, a pilot questionnaire on the relative difficulty of flight control tasks, tabulated data on crew flight control performance during mission time intervals, a duty cycle table, and graphs on pilot errors during duty cycles along with biomedical data. R.N.A.

N67-39356* Martin Co., Baltimore, Md. Man-Machine Engineering Dept.
ANALYSIS OF CREW PERFORMANCE IN THE APOLLO COMMAND MODULE. PHASE I

Milton A. Grodsky, David L. Glazer, and Albert R. Hopkins, Jr. Jun. 1966 163 p refs
(Contract NAS9-5730)
(NASA-CR-65755; ER-14264, Phase I) CSCL 05H

Studies were performed to determine the existence of any relationship between pilot performance and certain mission and equipment design variables identifiable in the Apollo command module. The data were obtained during simulated seven-day lunar landing simulations. Fifteen test pilots participated in the simulated missions and were organized into five three-man crews. Each flight control, switching, and guidance and navigation error was analyzed as to its nature, magnitude, direction, and etiology. The particular mission effects investigated, using a variety of statistical techniques, were: systems and phase effects, phase by system interaction effects, display/control configuration effects, effects on pilot reaction time, mission time, and duty cycle effects. Results indicated that a high level of performance was achieved and, for the most part, maintained throughout the simulated mission. Certain isolated effects were demonstrated such as an observed increase in switching performance variability over mission-time; however, few consistent trends were developed. Author

06 CHEMISTRY

Includes chemical analysis and identification (e.g., spectroscopy). For applications see: 17 Materials, Metallic; 18 Materials, Nonmetallic; and 27 Propellants.

N67-38082# General Dynamic Corp., San Diego, Calif. John Jay Hopkins Lab. for Pure and Applied Science.
CHEMICAL REACTIONS ON CLEAN SURFACES, USING MODULATED ATOMIC BEAM TECHNIQUES Annual Technical Summary Report, Apr. 1, 1966–Mar. 31, 1967
R. L. Palmer, J. N. Smith, Jr., and H. Saltsburg 25 Apr. 1967 22 p refs
(Contract AF 49(638)-1559)
(GA-7927; AFOSR-67-1898; AD-657364)

Progress is reported in a study of the H2-D2 exchange reaction which is catalyzed by a clean nickel surface. The preparation of both polycrystalline Ni target foils and vacuum deposited Ni target films is described. The main reaction parameters studied were the reactant beam flux, the beam temperature, and the surface temperature. TAB

N67-38099# Radio Corp. of America, Princeton, N. J. RCA Labs.
TRACE ANALYSIS OF SOLIDS BY MASS SPECTROMETRY Final Report, 1 Apr. 1966–30 Jun. 1967
Richard E. Honig Jul. 1967 79 p refs
(Contract AF 19(628)-5106)
(AFCRL-67-0451; AD-657334)

To improve the mass spectrometric analysis of insulating solids in powder form and of surfaces, a broad-based project was undertaken to evaluate and select suitable metallic powders and wires of highest purity. Thirty-six samples obtained from nine suppliers were analyzed in nearly 180 separate runs in considerable detail. At this time, the cleanest materials of general usefulness are gold and silver in powder and wire form, the sum total of all bulk impurities amounting to less than 10 ppm atomic. Work was continued on ion-sensitive thin-film plates, but so far no method was found that yields plates of sufficient sensitivity without heating the substrate to 180C. Work in other areas, such as laser impact evaporation, revised computer program, and quantitative determination will be described briefly. Author (TAB)

N67-38114# California Univ., Santa Barbara. Dept. of Chemistry.
SPECTROSCOPY OF EDA COMPLEXES AT HIGH PRESSURES. V: ABSORPTION OF CRYSTALLINE TCNE COMPLEXES
A. H. Kadhim and H. W. Offen Aug. 1967 18 p refs Submitted for publication
(Contract N00014-67-A-0120-0001)
(TR-6; AD-657123)

Five aromatic hydrocarbon–tetracyanoethylene (TCNE) complexes were dispersed in sodium chloride pellets and subjected to high pressures (0–25 KBAR). The charge transfer absorption was enhanced and displaced toward lower energies at the highest pressure. An exception is the crystalline complex HMB–TCNE which exhibits a blue shift at the highest pressure. The doublet structure in both charge transfer bands of naphthalene–TCNE can be observed at 1 atm and at higher pressures. The importance of the relative sizes of donor and acceptor in environmental interactions are discussed. Author (TAB)

N67-38179*# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
ELECTROCHEMICAL CHARACTERIZATION OF NON-AQUEOUS SYSTEMS FOR SECONDARY BATTERY APPLICATION Quarterly Report, May–Jul. 1967
M. Shaw, O. A. Paez, R. J. Radkey, and A. H. Remanick 21 Aug. 1967 88 p refs
(Contract NAS3-8509)
(NASA-CR-72293; QR-5) CFSTI: HC $3.00/MF $0.65 CSCL 07D

Multisweep cyclic voltammograms have been obtained for an additional 153 systems comprising silver, copper, nickel, cobalt, zinc, cadmium, molybdenum, indium, and iron electrodes in acetonitrile, butyrolactone, dimethylformamide, and propylene carbonate solutions of chlorides, perchlorates, and fluorides. The effect of solute concentration and water impurity on the cyclic voltammograms of a number of systems was determined. Voltammograms are presented for thirty-one of these systems. Tabular data includes peak current density, sweep index, anodic-to-cathodic peak displacement, coulombic ratio, and discharge capacity. Systems exhibiting no anodic or no cathodic peaks are listed, as well as those causing instrument overload due to a combination of high current and relatively low conductance. Author

N67-38189# Los Alamos Scientific Lab., N. Mex.
DIRECT CARBON REPLICATION OF URANIUM TETRAFLUORIDE FILMS ON URANIUM DIOXIDE
W. P. Ellis and Dana L. Douglass 30 Jun. 1967 12 p refs
(Contract W-7405-ENG-36)
(LA-3705) CFSTI: HC $3.00/MF $0.65

Direct carbon replicas of bare UO_2 and of UF_4 films formed on UO_2 by reaction with HF(g) were examined by electron microscopy. In contrast with the collodion replication study reported in LA-3183, C replication provides a correlation between optical blemishes in fluoride interference layers and surface morphology of the film. Observations indicate a growth of microcrystallites within the fluoride layer at reaction temperatures above 300°C. Author (NSA)

N67-38236# Göttingen Univ. (West Germany). Plant Physiology Inst.
INVESTIGATIONS ON THE ROLE OF ELECTRON CARRIERS IN PHOTOSYNTHESIS IN CELL-FREE SYSTEMS Final Scientific Report, 1 May 1963–30 Apr. 1967

A. Trebst 1 May 1967 19 p refs
(Contract AF 61(052)-716)
(AFCRL-67-0442; AD-657039)

A summary is given on the use of p-phenylenediamines as artificial electron donors and quinones as electron acceptors in investigations on the mechanism of electron transport of chloroplasts and photosynthetic bacteria. p-Phenylenediamines bypass the DCMU inhibition site of electron transport, DAD being the best electron donor for chloroplasts described so far. NADP reduction in chloroplasts at the expense of DAD is coupled to ATP formation, but at the expense of TMPD is not. NAD reduction in particles from Rhodospirillum at the expense of DAD is antimycin sensitive. Detailed studies of these systems give indication as to the location of the phosphorylating site and on the function of plastoquinone and of plastocyanin. Quinones were used as artificial electron acceptors in the study of the photooxidation of ascorbate and in the light inactivation of chloroplasts. Disalicylidenediamines are described as inhibitors of photosynthetic NADP reduction in chloroplasts, but not in photosynthetic bacteria. Author (TAB)

N67-38248 India. Dept. of Atomic Energy, Bombay.
VACUUM FUSION TECHNIQUE FOR GASES IN METALS
T. S. Krishnamoorthy, C. V. Krishnan, and Ch. Venkateswarlu 1967 21 p refs
(BARC-277)

A versatile vacuum fusion apparatus for the determination of gases in metals and alloys is described. Some salient points from experience in setting up and working with this technique for the last five years are recorded. Author

N67-38249 India. Dept. of Atomic Energy, Bombay.
A SPECTROGRAPHIC METHOD FOR THE ANALYSIS OF IMPURITIES IN SODIUM CHLORIDE
V. B. Kartha, T. S. Krishnan, N. D. Patel, and Sheila Gopal 1967 12 p refs
(BARC-284)

A spectrographic method for the determination of trace impurities in sodium chloride is described. The elements Cu, Co, Bi, Au, In, Ni, Pb, Pd, Tl, Cd, and Hg are concentrated by extraction with chloroform from a buffered solution of sodium chloride, using sodium diethyl dithiocarbamate as complexing agent. The choroform extract is evaporated on graphite and determined spectrographically with barium fluoride as carrier. The impurities can be determined in the 0.5–50 ppm range, in graphite matrix with a standard deviation of about ±8%, at the 20 ppm level. The method is applicable to other elements also that can be separated by suitable complexing agents. Author

N67-38259# Akron Univ., Ohio.
BORANES AS CARBONIUM ION ANALOGS
Brian G. Ramsey [1967] 8 p refs
(Contract N00014-67-A-0116-0001)
(TR-1; AD-657254)

A summary is given of the progress of work involving (1) the synthesis of 2-boranorbornane, and (2) electronic transitions in trialkylboranes and in arylboronic acids. TAB

N67-38267# Picatinny Arsenal, Dover, N. J. Propellants Lab.
METHYL CELLULOSE NITRATE
Jack Bobinski and Yvon P. Carignan Aug. 1967 39 p refs
(PA-TR-3476; AD-657214)

Methyl cellulose nitrate was prepared by nitration of methyl cellulose with 98% nitric acid dissolved in methylene chloride and, in 98% nitric acid without a solvent. With both procedures nitration is apparently complete within fifteen minutes. The heterogeneous nature of the methylation resulted in the non-uniformity of the substitution in the product. methyl cellulose nitrate. However, on the basis of the experimental data, it is postulated that methyl cellulose having a minimum degree of substitution of 1.8 would produce a uniformly substituted methyl cellulose nitrate. Nitration of methyl cellulose with a mixture of nitric and sulfuric acids is also discussed. Results of evaluation of the products for military application are presented. Author (TAB)

N67-38274# Marine Engineering Lab., Annapolis, Md.
INTERFACIAL FACTORS IN EVAPORATOR SURFACE FOULING, A STATE-OF-THE-ART SURVEY
B. H. Rankin and J. A. Bauman Mar. 1967 35 p refs
(MEL-24/67; AD-657127)

A survey of the literature was made to determine the state of the art in understanding the mechanism of evaporator-scale formation. The use of bulk conditions for the fluid and the heating surface does not provide a reasonably accurate model of the problem. Exploration of the variables in the interface region should provide a logical and more fruitful approach. Experimental examination of these interface variables must be made under precisely controlled conditions. Bench scale experiments are under way to establish the effects of surface material composition and roughness on scaling characteristics. Author (TAB)

N67-38275# California Univ., Livermore. Lawrence Radiation Lab.
ANALYTICAL CHEMISTRY SECTION Progress Report, Jan. 1–Dec. 31, 1966
J. E. Harrar, ed. 13 Apr. 1967 53 p refs
(Contract W-7405-ENG-48)
(UCRL-50006-67-1) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: automation in analytical chemistry; automation of the three-column gas chromatography; computer control for C, H, and N determinations in organic compounds; cathodic etching of metals for oxygen determination; vacuum fusion apparatus; automation of the CEC mass spectrometer; construction and testing of field operational differential mass spectrometer; modification of the coincident-field cycloidal-focusing mass spectrometer; a PDP-7 computer program for mass spectrometer data acquisition; automatic apparatus for determining He diffusion rates; powder densitometer; solution spectrum of Cf^{3+}; absorption spectra of Bk^{3+} and Bk^{4+}; homogeneous precipitation of $Be(OH)_2$; X-ray fluorescence; spectrophotofluorimetry; nuclear spin of ^{249}Bk from hyperfine structure in its emission spectrum; electron microprobe; transistorized, controlled-potential differential polarograph; modular, transistorized controlled-potential coulometer; atomic absorption and flame emission analysis; and various determinations. NSA

N67-38297# Cornell Univ., Ithaca, N. Y. Dept. of Chemistry.
MEASUREMENT OF RELAXATION TIMES OF CONCENTRATION FLUCTUATIONS BY THE ELECTRIC FIELD EFFECT ON CRITICAL OPALESCENCE Final Report, Jun. 1, 1966–Jul. 31, 1967
Peter J. W. Debye and Claude C. Gravatt 1 Aug. 1967 9 p refs
(Contract Nonr-401(58))
(AD-657208)

A brief summary is given of work involving (1) a study of the effect of applying electric fields to a binary liquid mixture near its critical solution temperature, Tc; (2) the angular dependence of experimental relaxation times in binary liquid systems; and (3) the scattering of light by binary liquid mixtures below Tc along the coexistance curve. Many aspects of this work were reported in detail in AD-642 606 and AD-649 343. TAB

N67-38308# Group for the Advancement of Spectroscopic Methods, Paris (France).
VIBRATIONAL ANALYSIS OF $^{13}C\,^{18}O_2$
Alain Chedin 15 Feb. 1967 34 p refs
(Contract AF 61(052)-911)
(AFCRL-67-0321; SR-1; AD-657085)

The report refers to the determination of the vibrational and potential constants for the symmetric isotopic species of CO2 except 12C18O2. TAB

N67-38317 India. Dept. of Atomic Energy, Bombay.
THE USE OF REACTOR FAST NEUTRONS IN THE ANALYSIS OF FLUORINE
G. R. Reddy and M. Sankar Das 1967 13 p refs
(BARC-280)

Utilization of reactor fast flux for the activation analysis of fluorine through $F^{19}(n,2n)F^{18}$ reaction is described. The average cross section for this reaction in a spectrum of fission neutrons has been determined using $Ni^{58}(n,p)Co^{58}$ as a monitor for flux measurements. The application of the reactor for determination of fluorine has been demonstrated by analysing teflon samples for its fluorine content. The practical sensitivity of the method is 500 μg of the fluorine under the experimental conditions. Author

N67-38318 Kyoto Univ. (Japan).
THEORY OF ROTATIONAL EXCITATIONS IN SOLID ORTHO-HYDROGEN
Shigeo Homma, Kankichi Okada, and Hirotsugu Matsuda Jul. 1967 42 p refs Submitted for publication
(RIFP-62)

A theoretical study is made on the rotational excitations in solid fcc orthohydrogen below $T\lambda$. The effective Hamiltonian which is quadratic in the rotational excitation operators of each molecule is set up by the method analogous to the Holstein–Primakoff theory of spin waves. The dispersion relation and the energy spectrum of the rotational excitation mode are obtained by the perturbational calculation. The expectation value of the angular momentum of each molecule generally vanishes in each energy eigenstate and the excited states can approximately be described in terms of quasi-particles for librational excitation which may be called librons. At 0°K libron has a minimum excitation energy of about 10 k_B and band width of about 5 k_B. The thermodynamic quantities such as free energy are numerically calculated using the state density, and the phase transition is estimated to be of the first order and $T\lambda \simeq 4.2$°K. Author

N67-38376# California Univ., Livermore. Lawrence Radiation Lab.
THE HEAT AND PRODUCTS OF DETONATION OF CYCLOTETRAMETHYLENE TETRANITRAMINE (HMX), 2,4,6-TRINITROTOLUENE (TNT), NITROMETHANE (NM), AND BIS[2,2-DINITRO-2-FLUORO-ETHYL]-FORMAL (FEFO)
Donald L. Ornellas 22 May 1967 7 p refs Presented at the 154th Natl. Meeting of the Am. Chem. Soc., Chicago, 10–15 Sep. 1967
(Contract W-7405-ENG-48)
(UCRL-70444; CONF-670904-4) CFSTI: HC $3.00/MF $0.65

Calorimetric measurements combined with product analysis were used to obtain fundamental information about the detonation process. The charges were completely confined by a 1.27-cm thickness of gold. The products and heats of detonation for HMX, TNT, NM, and FEFO from heavily confined charges are listed. The products represent those found on the Chapman–Jouguet isentrope at temperatures in the range 1500 to 1800°K. Proceeding down the scale of oxygen balance the proportion of carbon appearing as solid carbon increased and that appearing as carbon dioxide decreased. The proportion of hydrogen appearing as hydrogen gas increased and that appearing as water decreased. NM, a low-density explosive with a high hydrogen-to-carbon ratio, was the exception to the trends. NM has the same oxygen balance as TNT yet proportionally more carbon appeared as carbon monoxide and less as solid carbon that might be expected from the TNT results. Greater amounts of methane were present in NM products than for any of the other explosives. All of the fluorine in FEFO appeared as hydrofluoric acid. Unconfined charges of HMX and TNT were fired and the products compared favorably to calculated equilibrium products at constant volume. The TNT data indicated that solid carbon equilibrates rapidly during the reshocking of products that occur with unconfined charges. NSA

N67-38407# Oak Ridge National Lab., Tenn.
CHEMICAL SAFETY
G. W. Keilholtz 6 Jun. 1967 46 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1884) CFSTI: HC $3.00/MF $0.65

Chemicals in any form can be safely stored and used if their physical and chemical properties are fully understood and the necessary precautions, including the use of proper safeguards and protective equipment, are observed. Physical and chemical explosions are discussed with emphasis on ether peroxides and hydrogen. The hazards and toxic properties of certain metals and organic compounds are briefly described. The basic responsibility for safety remains with the individual and his supervision. They should fully understand the material properties and the precautions required in any set of chemical operations. Author (NSA)

N67-38414 India. Dept. of Atomic Energy, Bombay.
SPECTROGRAPHIC DETERMINATION OF RARE EARTHS IN SODIUM CHLORIDE
T. S. Krishnan, V. B. Kartha, N. D. Patel, and Sheila Gopal 1967 8 p
(BARC-283)

A spectrographic method for the determination of 0.05 to 2 PPM of rare earths impurities in sodium chloride is described. The method involves chemical pre-concentration of the rare earths as fluorides using lanthanum fluoride as a carrier and excitation of the spectra using a spark source. The standard deviation for the spectrographic estimation is of the order of ±9%, whereas that for the complete determination including chemical pre-concentration is of the order of ±15% at the 0.5 PPM level. Author

N67-38435# Bureau of Mines, Rolla, Mo.
A ONE-STEP OPERATION FOR RECOVERY OF MANGANESE AS CHLORIDE FROM ORES AND SLAGS
A. A. Cochran and W. L. Falke Jun. 1967 26 p refs
(BM-RI-6859)

Practical methods were studied for recovering manganese from low-grade ores and open hearth slags. A one-step operation was developed on a laboratory scale in which manganese and iron compounds are treated with chlorine, volatilized, and separated by selective condensation. Manganese recoveries of 90% to nearly 100% were obtained from nine of the most important domestic ores. The manganese chloride product was suitable for aqueous electrolysis with little additional purification. A complete, integrated process for the recovery and recycling of chlorine is proposed. This process appears to have distinct advantages over previously proposed manganese recovery processes, and, in sharp contrast to leaching procedures, it is applicable to practically any manganese-bearing material. Author

N67-38445 Commissariat a l'Energie Atomique, Saclay (France).
ELAN O: EXTRACTION OF CAESIUM FROM FISSION PRODUCTS ON MIXED EXCHANGER COLUMN-INACTIVE PILOT PLANT [ELAN O: EXTRACTION DU CAESIUM DES PRODUITS DE FISSION SUR COLONNE D'ECHANGEUR MIXTE-PILOTE INACTIF]
J. M. Courouble, A. Peeneau, and M. Prevotel Brussels, EURATOM, Aug. 1967 109 p In FRENCH; ENGLISH summary
(Contract EURATOM-025-62-10 RISF)
(EUR-3608.f)

The very encouraging laboratory results obtained with the phosphotungstate mixed exchanger led to quick consideration being given to the construction of a pilot plant capable of extracting caesium from actual fission-product solutions. The scale of 1000 Curies of caesium-137 extracted per operation was chosen in order to be compatible with the general shielding and effluent-discharge facilities. Before constructing this pilot, however, it was necessary to carry out various operations on an apparatus of the same size but operating in an inactive medium. Author

N67-38447 Commissariat a l'Energie Atomique, Saclay (France).
ANALYTICAL METHODS DEVELOPED IN THE COURSE OF FISSION PRODUCTS RECOVERY. PART I: ANALYSIS OF FISSION-PRODUCT SOLUTIONS [METHODES ANALYTIQUES MISES AU POINT DANS LE CADRE DE LA RECUPERATION DES PRODUITS DE FISSION. PREMIERE PARTIE: ANALYSE DE SOLUTIONS DE PRODUITS DE FISSION]
P. Azoeuf, A. Guillon, and J. Lefevre Brussels, EURATOM, Aug. 1967 89 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-025-62-10 RISF)
(EUR-3480.f, Vol. I)

The reason for the analysis of fission-product solutions is the need to know their exact composition in order to develop processes for the separation of certain fission elements. Sometimes it is necessary to determine only a few elements. The analytic methods adopted or developed for these purposes under the contract are described and their history recapitulated. The first part describes the separation techniques, which consist essentially of systematic separation by ion exchange and a series of selective separations by liquid–liquid extraction. A description is then given of the methods for chemically assaying inactive elements and for radiometric assay on the separate phases by the techniques previously indicated. A complete analysis usually entails a systematic separation and a number of selective separations, which may be accompanied by certain direct determinations described at the end of the report. Author

N67-38456# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
PROCESS VESSEL CALIBRATION, A TOOL FOR CONTROLLING MATERIAL UNACCOUNTED FOR (MUF)
L. W. Doher 12 Jun. 1967 8 p refs
(Contract AT(29-1)-1106)
(RFP-858) CFSTI: HC $3.00/MF $0.65

A method is described for locating and measuring nuclear material accumulations within the process vessels of a nuclear processing plant. The method was developed because if these unrecovered materials are not located and measured, the discrepancies between actual and calculated inventories remain unresolved. In this method, computerized calibration reports giving the volumes of process vessels are compared. Differences of volume that can be related to time and quantity of product-throughput are used for estimating accumulations of solid material. This feature enables the manager of a processing plant to rapidly determine the feasibility of solid-material recovery. Proposed refinements, to this method, include the utilization of the computer to provide current data from which the plant manager can predict the accumulation of SS materials. Author (NSA)

N67-38472# Case Inst. of Tech., Cleveland, Ohio.
POSITIVE AND NEGATIVE ION MOTION IN THERMAL OXIDE OF SILICON BY RADIOCHEMICAL AND MOS ANALYSIS
A. B. Kuper, C. J. Slabinski, E. Yon *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 232–243 refs (See N67-38461 23-09)
(Grant NGR-36-003-057)

Failure of conventional Si planar devices by surface potential shift due to oxide impurities, studied by combined MOS and radiochemical analysis, is discussed. Radioactive NaBr contaminant was used to study both anion and cation distributions and kinetics. Experimental evidence shows that Na in the oxide near the Si interface acts to accumulate electrons at the surface of n-type Si. At temperatures above 800°C, Br is found to diffuse into the oxide more slowly than Na and partly to neutralize Na^+. Conventional hot-bias drift experiments at 200°C have been extended to include impurity distribution as a function of time within the oxide. The kinetics of Na flow in the oxide to and away from the Si interface compared to Si surface potential shifts suggest the presence of a rapidly-equilibrating negative species which can neutralize Na^+ but not deplete an n-type Si surface. Author

N67-38558# California Univ., Santa Barbara. Dept. of Chemistry.
SPECTROSCOPY OF EDA COMPLEXES AT HIGH PRESSURES. IV: ABSORPTION OF SEVERAL HALOQUINONE COMPLEXES IN POLYMER MATRICES
H. W. Offen and T. T. Nakashima Aug. 1967 24 p refs Submitted for publication
(Contract N00014-67-A-0120-0001)
(TR-5; AD-657122)

Several haloquinone complexes were subjected to high pressures (0-20 kbar), and the resulting effects were registered in the charge transfer (CT) absorption spectra. The observed shift in the CT band maxima are discussed in terms of the various interaction terms, including CT forces, which contribute to the displacement of the ground relative to the excited CT state of the EDA-complex. The results indicate that the stronger complexes show the smaller red shift or even a blue shift in this pressure range. CT intensities in the 1-20 kbar interval are observed to change by -15% to +40% in this group of related complexes. Author (TAB)

N67-38575# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
LOW CURRENT DENSITY SPUTTERING ION SOURCE AND ITS APPLICATION TO THE ISOTOPIC AND QUANTITATIVE ANALYSIS OF NANOGRAM SAMPLES
James A. McHugh 26 Apr. 1967 23 p refs Presented at the 15th Ann. Conf. on Mass Spectrometry and Allied Topics, Denver
(Contract W-31-109-ENG-52)
(KAPL-P-3339; CONF-670534-1) CFSTI: HC $3.00/MF $0.65

The process of generating secondary positive or negative ions of a material by ion bombardment was applied to small solid-sample analyses. A compact low current density ion source employing this technique was constructed. The applications, advantages, and limitations of this type of source in the field of analytical mass spectrometry are discussed. In addition, a method for the quantitative determination of ^9Be, which is based solely on the quantitative interpretation of ^9Be ion emission from the sputtering source, is presented. Author (NSA)

N67-38593# Miami Univ., Coral Gables, Fla. Dept. of Chemistry.
PYREX MEMBRANE POTENTIAL IN BINARY NITRATE MELTS Special Report No. 5
A. G. Keenan, Karl Notz, and F. L. Wilcox 1 Sep. 1967 10 p refs
(Contract Nonr-4008(07))
(AD-657447)

Emf measurements are reported at 350C for cells with a Pyrex membrane and containing binary nitrate melts of the type MNO3 AgNO3. The ion exchange model fits the data whereas the liquid junction model does not. Selectivity constants have the same order in the two systems as well as in aqueous solution. The significance of this is discussed. This work is part of the program to determine the mechanism of decomposition of chloride-catalysed ammonium nitrate melts. Understanding is required of Pyrex membrane potentials in order to develop a reference electrode for in situ acidity measurements in fused salts. Author (TAB)

N67-38622# California Univ., Berkeley. Lawrence Radiation Lab.
MAGNETIC RESONANCE SPECTRA OF VCl_4 AND OTHER PARAMAGNETIC SPECIES
David Wixon Pratt (Ph.D. Thesis) Apr. 1967 266 p refs
(Contract W-7405-ENG-48)
(UCRL-17406) CFSTI: HC $3.00/MF $0.65

Techniques for performing electron spin resonance studies of paramagnetic species in glasses or polycrystalline matrices at temperatures below the λ-point of liquid helium have been developed and the experimental procedures have been described in detail. These methods have been applied in the investigation of the transition metal compounds VCl_4 and $V(CO)_6$. The ESR spectrum of VCl_4 at liquid helium temperatures has been studied in the pure compound and in the following solvents: *n*-heptane, mineral oil, CCl_4, $SiCl_4$, $TiCl_4$, and $SnCl_4$. The spin Hamiltonian parameters for pure VCl_4 and VCl_4 in *n*-heptane and mineral oil have been obtained. These have provided significant evidence for the presence of a Jahn–Teller effect in this molecule at low temperatures. The spectra in the remaining solvents are quite complex but a partial assignment of these has been made. The effects of both static and dynamic Jahn–Teller distortions on the ESR spectra of VCl_4 in these solvents are discussed in detail. The relaxation times for the unpaired electron in VCl_4 have been measured over a wide temperature range using a variety of techniques including pulse experiments. These results are discussed in terms of the existing theories for spin relaxation in solids at low temperatures and a model for relaxation in VCl_4 in the temperature range 1 to 50°K has been proposed. Author (NSA)

N67-38624# California Univ., Livermore. Lawrence Radiation Lab.
DETERMINATION OF THORIUM IN THORIUM DIOXIDE–TUNGSTEN MIXTURES
Richard E. Brandt 20 Jun. 1967 7 p refs
(Contract W-7405-ENG-48)
(UCID-15162) CFSTI: HC $3.00/MF $0.65

A double-fusion technique was used for the dissolution of thorium dioxide–tungsten mixtures prior to the titrimetric determination of thorium. The tungsten was dissolved with an initial $NaOH–NaNO_3$ fusion leaving a gelatinous thorium hydroxide or flocculent thorium dioxide precipitate. After filtering, the thorium precipitate was fused with $K_2S_2O_7$. The soluble thorium was then titrated with a standard EDTA solution. Author (NSA)

N67-38625# California Univ., Livermore. Lawrence Radiation Lab.
NOTES ON THE GROWTH OF LiH SINGLE CRYSTALS
Edward Catalano, Donald D. Kingman, and Emmett W. Wrenn 31 May 1967 14 p refs
(Contract W-7405-ENG-48)
(UCID-15143) CFSTI: HC $3.00/MF $0.65

The technique used for the production of large single crystals of LiH is described. The steps are: purifying lithium metal by distillation, sealing the purified lithium metal within a pure iron crucible, hydriding the lithium metal after diffusing hydrogen through the crucible walls, growing the LiH crystals by the Störber process, and annealing the crystal before removing it from the crucible. Author (NSA)

N67-38640# Sandia Corp., Albuquerque, N. Mex.
A STRUCTURE-PROPERTY STUDY OF THERMOSETTING RESIN SYSTEMS. I: PREPARATION AND POLYMERIZATION OF ALKENYL-SUBSTITUTED IMIDES AND THEIR EPOXY DERIVATIVES
D. R. Anderson and C. J. Rogers Jun. 1967 17 p ref
(Contract AT(29-1)-789)
(SC-RR-67-316) CFSTI: HC $3.00/MF $0.65

The initial phase of the structure/property study (i.e., developing a characterizable thermosetting polymer system with a capability of synthetic variation) was completed. Several N-alkyl- and alkenyl-substituted imides and their epoxy derivatives were prepared and polymerized. Author (NSA)

N67-38681# Advisory Group for Aerospace Research and Development, Paris (France).
RECENT ADVANCES IN AEROTHERMOCHEMISTRY, VOLUME 1
Irvin Glassman, ed. (Princeton Univ.) 1967 462 p refs Papers presented at the 7th AGARD Colloq., Oslo, 16–20 May 1967
(AGARD-CP-12, Vol. 1) CFSTI: HC $3.00/MF $0.65

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12. PERFORMANCE OF AN ARC-HEATED SUPERSONIC MOLECULAR BEAM AND ITS APPLICATION TO MOLECULE–MOLECULE COLLISION STUDIES E. L. Knuth and

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14. CHEMICAL REACTION CROSS-SECTIONS DETERMINED BY MOLECULAR BEAMS IN THE 10 eV ENERGY RANGE N. G. Utterback (Gen. Motors Corp.) p 363–375 refs (See N67-38695 23-06)

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N67-38682# National Bureau of Standards, Washington, D. C.
MICROSCOPIC AND MACROSCOPIC APPROACH TO CHEMICAL RATE PROCESSES
Kurt E. Shuler *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 1–20 refs (See N67-38681 23-06)

Chemical rate processes, like all other transport processes, can be considered on two levels—the molecular one and the statistical one. On the molecular (microscopic) level one is concerned with binary (or higher order) collisions between single atoms and/or molecules. Such elementary processes can best be studied through the scattering of the reactant species in atomic and molecular beams. The quantity of interest is the reactive scattering cross-section; the theoretical approach involves the quantum theory of scattering. On the statistical (macroscopic) level one is concerned with the interactions of an ensemble of atoms and molecules characterized by their velocity and internal energy distribution functions. The experimental quantity of interest is now the rate coefficient; the theoretical approach involves the derivation and solution of the appropriate macroscopic transport equation in terms of the (microscopic) scattering cross-sections and the distribution functions of reactants and products. These two approaches to the study of rate processes and their connection are discussed. Author

N67-38683# Gottingen Univ. (West Germany). Institut fuer Physikalische Chemie.
UNIMOLECULAR THERMAL DISSOCIATION OF SMALL MOLECULES
J. Troe and H. Gh. Wagner *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 21–44 refs (See N67-38681 23-06)

Experimental investigations on the decompositions of three- and four-atomic molecules are reviewed and discussed. Data are available on the dissociations of CO_2, CS_2, COS and N_2O, of H_2O, O_3, SO_2, NO_2, BrCN, ClCN, NOCl, F_2O and NF_2 and of H_2O_2, NH_3, C_2H_2, NO_2Cl, F_2O_2, $FClO_2$ and $(CN)_2$. The first group of triatomic molecules dissociates via spin-forbidden transitions, therefore in the cases of N_2O and CS_2 the high pressure limiting rate was obtained at pressures of several low atmospheres in addition to the low pressure region. The remaining reactions of triatomic molecules are spin-allowed and were studied only in the low pressure region. Measurements partly in the low pressure region, partly in the transition range up to the high pressure limit are available for four-atomic molecules. The experimental properties are described in terms of the quantum forms of simple theories of unimolecular reactions. Many experiments were made at temperatures below the characteristic temperatures of some oscillators and are always to be interpreted by means of true partition function of the molecules. Theories of strong and weak collisions are discussed in the case of dissociations of small molecules in monoatomic carrier gases. Author

N67-38684# Copenhagen Univ. (Denmark). Chemistry Lab. III.
THE RELAXATION AND DISSOCIATION OF SMALL MOLECULES
Thor A. Bak and Edward R. Fisher *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 45–57 refs (See N67-38681 23-06)

The relaxation and dissociation of diatomic molecules is briefly reviewed in the two approximations for which a complete discussion can be given, viz., the almost adiabatic case where only a small amount of energy is transferred in a collision and the extremely non-adiabatic classical case where a large transfer of energy in a collision is possible. The quantum mechanical transition probabilities are then calculated using the sudden approximation and the rate of dissociation is found. Author

N67-38687# University Coll. of North Staffordshire, Keele (England). Dept. of Chemistry.
A SHOCK TUBE STUDY OF THE INFRARED EMISSION FROM HCl: VIBRATIONAL RELAXATION TIMES FOR THE UPPER STATES
Peter Borrell and R. Gutteridge *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 131–146 refs (See N67-38681 23-06)

The infrared emission from the third vibrational level of shock heated HCl has been observed and measured. The relaxation appears to follow a simple exponential form with a somewhat longer relaxation time than that measured previously. Two mechanisms for the excitation are considered: direct excitation, and excitation by rate determining population of the first level followed by rapid equilibration of the upper levels. It is suggested that the second mechanism is inapplicable since with earlier measurements on CO, a two step process was found and it is pointed out that calculations with the model lead to a complex relaxation. It is suggested that the difference between the hydrogen halides and CO might lie in the mechanism of their relaxation which occurs by rotation/vibration exchange for HCl rather than translation/vibration for CO and the question is asked whether direct excitation to the upper vibrational levels is allowed for rotation–vibration energy exchange. Author

N67-38688# Cornell Univ., Ithaca, N. Y.
THE ROLE OF VIBRATIONAL EXCITATION IN ATOM SWITCHING REACTIONS
S. H. Bauer *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 147–164 refs (See N67-38681 23-06)
(Grant NsG-116-61; Contracts AT(30-1)-3211; AF 49(638)-1448)

The reaction, $HX+DY \rightarrow HY+DX$, is investigated. Classical statistical mechanics leads to a pre-exponential factor of the form $(1/e\ell)(\epsilon/kT)^2$; rough quantum mechanics calculations indicate an activation energy $\epsilon \cong 60$ kcal/mole. The data, obtained from the shock tube measurements of D/H exchange rates between D_2 and CH_4, NH_3, H_2S, HC, and H_2 are in disagreement with both predictions. Shock tube techniques proved to be the only means by which a sample of gas can be heated sufficiently rapidly and homogeneously so that one may separate in time the successive flow of energy from translation and rotation to vibrations and eventually produce chemical changes. The analytic results show that not only are there restrictions on the relative efficiency of utilizing the energy associated with the different molecular degrees of freedom, but also that the relative kinetic energy of translation plays practically no role; it is the vibrational energy of D_2 which dominates the rate of exchange. Author

N67-38696# General Motors Corp., Santa Barbara, Calif. Defense Research Labs.
CHEMICAL REACTION CROSS-SECTIONS DETERMINED BY MOLECULAR BEAMS IN THE 10 eV ENERGY RANGE
Nyle G. Utterback *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 363–375 refs (See N67-38681 23-06)

The production of molecular beams in the 10 eV energy range by the technique of ionization by electron impact, electrostatic acceleration, and neutralization by resonant charge transfer is discussed. The application of such a beam to the determination of chemical reaction cross sections is considered in detail, particularly as to the present study of the reactions $N_2+CO \rightarrow NO^+ + CN^-$ and N_2 (15, 15)+N_2 (14, 14) $\rightarrow$ N_2 (15, 14)+N_2 (15, 14)+e. Other methods for producing neutral beams in this energy range are described. Of particular interest is the possibility for producing beams of excited atoms and molecules. Author

N67-38703# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
SPECTROPHOTOMETRY OF NEPTUNIUM IN NITRIC ACID SOLUTIONS
Andrew J. Johnson and Glenn A. Shepherd 7 Jul. 1967 9 p refs
(Contract AT(29-1)-1106)
(RFP-958) CFSTI: HC $3.00/MF $0.65

Studies were made of the effect of varying nitric acid concentrations in neptunium solutions on the oxidation states of the neptunium present. Spectrophotometric methods were used to determine the proportions of neptunium(IV), (V), and (VI) present in nitric acid solutions varying between one and ten normal (1 and 10 N). Absorption spectra of both the neptunium(IV) and (VI) complexes with nitrate were identified and are given. Author (NSA)

N67-38706# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
PROPERTIES OF PLUTONIUM OXIDE, PART II
Garrel F. Molem and Robert W. White 12 Jul. 1967 11 p ref
(Contract AT(29-1)-1106)
(RFP-927) CFSTI: HC $3.00/MF $0.65

The effect of the maximum exposure temperature and the time of exposure on the properties of PuO_2 are described. Results showed that temperature, and the interaction of temperature and time, had a significant effect on the properties measured. Time alone did not have a significant effect on the properties measured. Author (NSA)

N67-38780# Princeton Univ., N. J. Plasma Physics Lab.
CHEMICAL ATTACK OF METALS BY MOLTEN SALTS
J. F. Zoeller and E. F. Johnson *In its* Plasma Phys. Lab. May 1967 p 443–448 refs (See N67-38725 23-25)

Chemical interactions between pure nickel surfaces and lithium nitrate were evaluated at elevated temperatures. Pre-weighted nickel specimens were immersed in the heated molten salt for a predetermined reaction period; upon withdrawal, nitrate decomposition was quenched by rapid cooling, the nickel was weighted, and the melt was analyzed for nickel content. Results showed that the major reaction product was a nickel oxide film that adhered to the nickel surface. This first reaction stage was followed by a slow nickel diffusion through the oxide film. Solution of nickel at 500°C was too slow to correlate with the immersion period. The oxide film protected and partially passivated the nickel. It was concluded that a high purity nickel resisted molten salt attack better than low-purity nickel. G.G.

N67-38819# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
PERCENTAGE DETERMINATION OF OXYGEN, NITROGEN, CARBON AND SILICIUM IN REFRACTORY METALS AND THEIR ALLOYS BY EMISSION SPECTROMETRY IN THE VACUUM U.V. SPECTRUM [DOSAGE DES ELEMENTS OXYGENE, AZOTE, CARBONE ET SILICIUM DANS LES METAUX REFRACTAIRES ET LEURS ALLIAGES, PAR SPECTROMETRIE D'EMISSION DANS L'ULTRAVIOLET LOINTAIN]
Frima Malamand 1967 43 p refs In FRENCH; ENGLISH summary
(ONERA-TN-105(1967))

The lines of the vacuum spectrum between 500 Å and 200 Å are used to determine simultaneously the percentages of oxygen, nitrogen, carbon, and silicon in the refractory metals niobium, tantalum, molybdenum, and in niobium alloys. The instrument used includes a spark chamber, a spectrograph incorporating a grating at a pressure of 10^{-6} mm Hg, a high energy excitation source, and a direct reading system. For each element several lines are used corresponding to high ionization levels O_{VI}, N_V, C_{IV}, Si_{IV}; the ratios of the intensities being established by means of the intensity of the beam reflected by the grating. Concentrations of 10 PPM for O^2 and C, and of 20 PPM for N^2 are reached. These limits may still be lowered. The operational mode, the results obtained, and the advantages of this method are described in detail. Author

N67-38826# Arizona Univ., Tucson. Dept. of Chemistry.
THE DEVELOPMENT AND TESTING OF ORGANIC REAGENTS FOR USE IN INORGANIC ANALYSIS Progress Report, Sep. 1, 1966–May 15, 1967
Henry Freiser 27 Apr. 1967 27 p
(Contract AT(11-1)-676)
(COO-676-1) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: adduct formation in solvent extraction of chelates; mixed ligand formation in chelate extraction; calorimetric determination of enthalpies of chelate formation; ion pair extraction involving metallochromic indicators; and sulfur-containing ligands. Supporting data for the various studies are appended. NSA

N67-38883# California Univ., Berkeley. Lawrence Radiation Lab.
NUCLEAR MAGNETIC RESONANCE RELAXATION OF OXYGEN 17 IN AQUEOUS SOLUTIONS OF FERRIC ION
Malcolm Robert Judkins (Ph.D. Thesis) May 1967 75 p refs
(Contract W-7405-ENG-48)
(UCRL-17561) CFSTI: HC $3.00/MF $0.65

The ^{17}O NMR signal in aqueous solutions of ferric ion was studied as a function of temperature, frequency, and solution composition in order to separate the various effects arising from ferric ion and its hydrolyzed species. The principal species affecting the ^{17}O NMR width by water exchange were found to be Fe^{3+}, $FeOH^{2+}$, and $Fe_3(OH)_4^{5+}$, the ferris ion produces line broadening arising from exchange out of both a first and an outer coordination sphere. The first coordination sphere waters exchange slowly enough to be in the exchange controlled region. The outer coordination sphere exchange is rapid and the ^{17}O nuclear spin is probably relaxed by a combination of scalar coupling and $\Delta\omega$ mechanisms. The first and outer coordination sphere effects cannot be separated unequivocally and consequently only a range of values is reported for the exchange rates. It appears that $FeOH^{2+}$ and $Fe_3(OH)_4^{5+}$ are in the relaxation controlled region for the water exchange. Only a lower limit for the exchange rate from the first coordination sphere is given. The relaxation seems to be a consequence of both scalar coupling and $\Delta\omega$ mechanisms. The species $Fe_2(OH)_2^{4+}$ does not contribute measurably to the line broadening, presumably because of a low magnetic moment. Author (NSA)

N67-38870# Naval Radiological Defense Lab., San Francisco, Calif.
RADIOPHOTOLUMINESCENCE SPECTRA OF SILVER-ACTIVATED DOSIMETER GLASSES
Klaus Becker and Donald W. McQuilling 23 Jun. 1967 29 p refs
(USNRDL-TR-67-66; AD-656896)

The absolute radiophotoluminescence spectra of several commercial and experimental AG-activated dosimeter glasses were

measured with a specially designed apparatus. Depending mainly on the glass base composition, maxima between 615 and 640 millimicrons and a slow decrease in the red were found. The effect of build-up, silver concentration and dose of the RPL spectral shape is small. The influence of very high doses and thermal annealing was also measured. Author (TAB)

N67-38892# Harvard Air Cleaning Lab., Cambridge, Mass.
REMOVAL OF IODINE AND METHYL IODIDE BY AEROSOL FORMATION WITH HYDRAZINES
F. J. Viles, Jr. and L. Silverman *In its* Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 273–297 refs (See N67-38880 23-22)

Studies were made of the gas phase reactions of I_2 with hydrazine and with its unsymmetrical dimethyl derivative. Hydrazine air concentrations of 765 to 890 ppM proved adequate for efficient aerosol formation and removal of both I_2 and methyl iodide. For dynamic conditions involving aerosol filtration, reaction times of several minutes were required. Reaction and natural aerosol removal processes under static conditions required several hours. Hydrazine concentrations of approximately 37 ppM were effective in removing methyl iodide only when alkali was present to remove the interference created by normal air concentrations of CO_2. Although tests were not made to determine CO_2 interference with the methyl iodide—unsymmetrical dimethyl hydrazine reaction at low concentrations, methyl iode removal was complete with 90 to 100 ppM of this reactant in the absence of CO_2. Efficient aerosol formation and removal of I_2 by reaction with low hydrazine concentrations occurred in the presence of normal levels of CO_2. Author (NSA)

N67-38893# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
REMOVAL OF METHYL IODIDE FROM SIMULATED REACTOR CONTAINMENT ATMOSPHERES WITH HYDRAZINE
J. Mishima, L. C. Schwendiman, L. L. Burger, and R. A. Hasty *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 298–318 refs (See N67-38880 23-22)
(Contract AT(45-1)-1830)

The reaction of hydrazine and methyl iodide is under study to determine the feasibility of using hydrazine in reactor spray systems to remove organic and molecular forms of radioactive iodine. Rate studies showed that the static removal of methyl iodide from the vapor phase over a 50% hydrazine solution proceeds with a half-life of about six minutes at 50°C. Reaction rate and/or rate of transfer to the solution varies with airborne methyl iodide concentration, liquid hydrazine concentration and the available liquid surface area. Spraying 35% hydrazine solutions through air containing methyl iodide at room temperature and at 75°C effectively scavenges methyl iodide even in the presence of 50 mg/m^3 of molecular iodine. Author

N67-38894# Oak Ridge National Lab., Tenn. Reactor Chemistry Div.
REMOVAL OF RADIOACTIVE METHYL IODIDE FROM STEAM–AIR SYSTEMS
R. D. Ackley, R. E. Adams, and W. E. Browning, Jr. *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 331–347 refs (See N67-38880 23-22)

Removal of radioactive methyl iodide from flowing steam–air by impregnated charcoals has been investigated in two series of tests. Temperatures and pressures for one series were around 212°F and 14.4 psia, and, for the other series, generally around 280°F and 60 psia. According to the results obtained, $CH_3{}^{131}I$ can still be trapped effectively at these higher temperatures and, also, at the higher pressures by an appropriately selected impregnated charcoal provided the charcoal has not been damaged and provided the prevailing relative humidity in the charcoal does not exceed 90%. Author

N67-38907# Michigan Univ., Ann Arbor. Dept. of Chemistry.
STRAIN ENERGIES AND THERMAL PROPERTIES OF GLOBULAR AND POLYNUCLEAR AROMATIC MOLECULES
Edgar F. Westrum, Jr. and Shaio-wen Wong Apr. 1967 7 p Presented at the Thermodyn. Symp., Heidelberg, 12–14 Sep. 1967
(Contract AT(11-1)-1149)
(COO-1149-92; CONF-670913-3) CFSTI: HC $3.00/MF $0.65

From the measured enthalpies of combustion of bicyclo[2.2.2]-octene (8-ene) and six closely related substances plus two bicycloheptanes and four polynuclear aromatic hydrocarbons, enthalpies of formation and strain energies were calculated by several schemes. It was concluded from mechanics that the non-twisted boat form (D_{3h}) is the most stable configuration of 8-ane. Observed strain energies for 8-ene (9.20 kcal/mole) and for quinuclidine (9.46) are consistent with the presence of strain energy anticipated for the eclipsed configuration of the hydrogens. Introduction of an equatorial double bond increased the strain energy to 9.69 kcal/mole. Bicyclononane has high strain energy as a consequence of the overcrowded carbon atoms on the bridge ring. Replacement of this CH_2 by NH or O reduces the strain to 7 and 5 kcal/mole, respectively. The strain energies of biphenylene, fluoranthene, and perylene as well as bicycloheptanes were also evaluated and interpreted. Author (NSA)

N67-38911# Syracuse Univ. Research Inst., N. Y. Dept. of Chemistry.
PHASE EQUILIBRIA AND SPECIFIC VOLUMES OF LIQUID METALS AND ALLOYS
Frank A. Kanda, William Carter, Michael Falkiewicz, Richard Colburn, and Roger Grant May 1967 31 p refs
(Contract AT(30-1)-2731)
(NYO-2731-8; CHEM-1820.871; Rept.-8) CFSTI: HC $3.00/MF $0.65

Developments in liquid metal studies are reported. These include density studies on Tl–Te and Tl–Mg, viscosity studies on Hg, Pb, and Sn, and crystal structure studies of $SrMg_2$ and Sr_2Mg_{17}. NSA

N67-38912# IIT Research Inst., Chicago, Ill. Dept. of Chemistry.
AROMATIC HYDROGEN EXCHANGE Annual Report, Sep. 1, 1965–Jan. 14, 1967
A. J. Kresge May 1967 16 p refs
(Contract AT(11-1)-1025)
(COO-1025-34) CFSTI: HC $3.00/MF $0.65

The proton transfer process was studied by using aromatic protonation. Activation parameters were determined for the aromatic protonation of 1,3-dimethoxybenzene with H_3O^+ and $HClO_2H$ and of 1,3,5-trimethoxybenzene with H_3O^+ and $H_2PO_4^-$. The entropies of activation for kinetic aromatic protonation showed a striking resemblance to the entropies of ionization of the corresponding catalyst acids. Two primary hydrogen isotope effects, that on bond-breaking in the catalyzing acid and that on bond-breaking in the cationic intermediate, are discussed. Several secondary isotope effects were of consequence. Two resulted from hybridization changes in the non-reacting carbon–hydrogen bond of the aromatic substrate situated at the seat of exchange. A third secondary isotope effect was produced by changes in the strength of the non-reacting bonds of the hydronium ion. Several triphenylmethanols were labeled with deuterium in various ring positions and the extent of their ionization in strongly acidic media was measured. It was shown that the effect of isotopic substitution at the various ring positions was additive and that deuteration in

the ortho and meta positions had approximately twice the influence as deuteration in the para position. The hydrolysis of vinyl ether is also discussed. NSA

N67-38913# Arizona Univ., Tucson.
AN INVESTIGATION OF STERIC AND SYNERGIC EFFECTS IN METAL CHELATES Technical Progress Report, Sep. 1, 1966–Apr. 1967
Quintus Fernando 12 Apr. 1967 7 p Presented at 10th Intern. Conf. on Coord. Chem., Tokyo
(Contract AT(11-1)-1654)
(COO-1654-1; CONF-670908-1) CFSTI: HC $3.00/MF $0.65

Studies were made on the properties of selected metal chelates in solution and their structures in the solid state. The metal chelates consisted of the ligand, 2-methyl-8-quinolinol, and trivalent metal ions such as Al(III), Ga(III), and In(III). Very small single crystals of the 1:2 as well as the 1:1 copper–1-(2-pyridylazo)-2-naphthol (PAN) complexes were grown from ethanol solutions. Preliminary X-ray data on the structure of the compound are given. The structure of the metal chelate adduct of bis-(acetylacetonato)-copper(II) with quinoline was also studied. It was found that adduct formation not only destroyed the planarity of the two chelate rings, but also altered the symmetry of the molecule. NSA

N67-38917# Amsterdam Univ. (Netherlands).
CALIBRATION OF A RADIUM (α,n) BERYLLIUM NEUTRON SOURCE
Pieter Willem Louwrier (Ph.D. Thesis) 1966 88 p
(NP-16854)

The absolute yield of the Ra–Be source was measured by means of the manganese sulfate bath method. The ^{56}Mn activity was calibrated by $4\pi\beta$–γ coincidence measurements. To analyze the composition of the solution, a special type of activation analysis was used. This method makes possible the determination of the main component of a solution with a good accuracy in the presence of impurities of various kinds. Another type of activation analysis has been used to measure the influence of the cross section of the impurities present in the solution. The escape of neutrons from the cylindrical tank was determined by calibrating the source in three tanks with increasing diameter and height. In addition the escaping neutrons were measured by means of a BF_3 counter. The absorption of neutrons in the source was determined by placing cylindrical cadmium cavities of different size around the source. In order to obtain an independent value for the neutron output of the source, a solution of sodium acetate was used instead of manganese sulfate. Author (NSA)

N67-38927# Japan Atomic Energy Research Inst., Tokyo.
DEFECT STRUCTURE OF BORATE GLASSES IRRADIATED WITH GAMMA-RAYS
Yasuo Nakai Jun. 1967 14 p refs Submitted for publication
(NSJ-TR-84) CFSTI: HC $3.00/MF $0.65

Electron spin resonance spectra were observed for various γ-ray irradiated borate glasses such as wet and deuterated borate glasses and alkali borate glasses containing more than 25 mole % alkali oxide. The irradiated wet and deuterated borate glasses give spectra consisting of five peaks (P_S center) which arise from the hyperfine interaction with a ^{11}B nucleus. The pattern of the ESR spectrum of P_S center has been suggested to be dependant on the alkali oxide concentration and due to the glass structure made of boron–oxygen bonding. In addition to the five peaks, the observed spectra display a doublet (P_H center) with 504 gauss separation for the irradiated wet borate glasses and a triplet (P_D center) with three equally spaced lines with a 77 gauss separation for the irradiated deuterated borate glasses. The R_H center and R_D center are attributed to proton and deuteron hyperfine splittings. The mechanism of the formation of the hydrogen center and the recombination between R_S center and P_H center have been discussed. Author

N67-38939# European Atomic Energy Community, Brussels (Belgium).
PRECISE DETERMINATION OF URANIUM BY A POTENTIAL CONTROL OF COULOMETRY FOR URANIUM AND URANIUM–ALUMINUM SOLUTIONS [DETERMINATION PRECISE DE L'URANIUM PAR COULOMETRIE A POTENTIEL CONTROLE. APPLICATION AUX CAS DES SOLUTIONS D'URANIUM ET D'URANIUM–ALUMINIUM]
Y. Le Duigou and K. F. Lauer Aug. 1967 27 p refs In FRENCH; ENGLISH summary
(EUR-3601.f) CFSTI: HC $3.00/MF $0.65

The uranium content of solutions is determined by controlled potential coulometry with a standard deviation of 0.05% for a number of measurements higher than 10. The amount of uranium taken for each measurement is about 25 mg. The introduction of a correction corresponding to the current intensity at the end of reduction and time of the measurement, improves this precision by a factor of two. The same method applied to aluminium–uranium alloys containing about 24% uranium give a standard deviation of 0.05% on the uranium content. Author

N67-38943* Catalyst Research Corp., Baltimore, Md.
TEST EVALUATION OF FUEL CELL CATALYSTS, MAY 15, 1967–AUGUST 15, 1967
H. J. Goldsmith, J. R. Moser, and T. Webb 15 Aug. 1967 35 p ref
(Contract NASw-1577)
(NASA-CR-89308) CSCL 07D

Corrosion potentials of Raney cobalt; Raney nickel; iron; Raney alloys of nickel, cobalt, and silver; carbides; and nitrocarbides were obtained to test these materials as anodic catalysts for ammonia in 30% KOH, carbon monoxide in 2N H_2SO_4, and pH-3 acetate buffer fuel-cell electrolytes. Surface areas were determined by double layer capacitance. Results indicate that none of the nickel or cobalt materials appear to be very good catalysts for ammonia oxidation, although some were three times as good as the iron catalysts. For carbon monoxide two nickel–silver materials (RAL-10 and 32NC) look promising, and three iron materials (10C, 23C, and 1NC) may be potentially good catalysts with increased surface areas. Acetate electrolyte buffered at pH-3 gives better potentials and less corrosion than 2N H_2SO_4, but at the expense of lower currents. L.S.

N67-38948# Centre d'Etude de l'Energie Nucleaire, Mol (Belgium).
DETERMINATION OF BURN-UP BY RADIOCHEMICAL ANALYSIS OF CS-137 [DETERMINATION DU TAUX DE COMBUSTION PAR L'ANALYSE RADIOCHIMIQUE DU CS137]
A. Terzaghi, J. Ketels and E. Van Hoof Aug. 1967 18 p refs In FRENCH; ENGLISH summary
(Contract EURATOM-006-60-5 BRAB)
(EUR-3603.f) CFSTI: HC $3.00/MF $0.65

The burn-up determination in low enrichment UO_2 and UO_2–PuO_2 fuels is based on Cs137 radiochemical analysis. A radiochemical method and its application for the analysis of fuels with different plutonium content are described. Results obtained by the radiochemical analysis and the gamma spectrometry of fuel solutions using a Ge–Li detector are compared. The accuracy of parameters involved in the burn-up calculation is estimated. Author

N67-38954# Bettis Atomic Power Lab., Pittsburgh, Pa.
OPTICAL ABSORPTION SPECTRA OF UO_2 AND ITS SOLID SOLUTIONS. LWB-LSBR DEVELOPMENT PROGRAM

R. M. Berman Jun. 1967 67 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-316) CFSTI: HC $3.00/MF $0.65

The infrared absorption spectrum of UO_2 shows a complicated series of peaks, apparently arising from electronic transitions in the U^{4+} ion, as modified by the eight surrounding oxygen ions. This spectrum is modified largely by wavelength shifts as ThO_2 or ZrO_2 is added in solid solution. On oxidation (except in zirconia materials, where ordered solid solutions apparently prevent the uranium ions from being adjacent to interstitial oxygens), overall absorption increases, particularly at short wavelengths in the visible or near-infrared range. The peaks of the spectrum become ill-defined. New peaks appear at 1.60 and 1.37 microns; they are attributed to U^{5+} and U^{6+}, or oxygen complexes containing these ions.
Author

N67-38990# Battelle Memorial Inst., Columbus, Ohio.
CORROSION OF CONSTRUCTION MATERIALS IN BOILING 13M NITRIC-0.1M HYDROFLUORIC ACIDS
Paul D. Miller, Elmer F. Stephan, Warren E. Berry, and Walter K. Boyd 30 Mar. 1967 30 p refs
(BMI-X-434) CFSTI: HC $3.00/MF $0.65

Welded and unwelded coupons of candidate constructional materials were exposed to a boiling solution (120°C) of 13M HNO_3 and 0.1M HF for times up to 240 hr. The study was made to aid ORNL in choosing a material of construction for equipment once planned for leaching waste solids from the primary reactor of the Fluidized-Bed Volatility Pilot Plant. HAPO 20(50 wt % Ni–25 wt % Cr–16 wt % Fe–6 wt % Mo–1 wt % Cu) was the most resistant of the materials studied when the durability of both welds and base metal was considered. Several other alloys showed fairly good resistance to the leach solution, but all were preferentially attacked near, or in, the welded areas; they were Corronel 230 (Ni–36 wt % Cr–5 wt % Fe–1 wt % Cu–1 wt % Mn–1 wt % Ti), Ni–50 wt % Cr, and Haynes 25 (50 wt % Co–20 wt % Cr–15 wt % W–10 wt % Ni–3 wt % Fe–1.5 wt % Mn).
Author (NSA)

N67-39047# Aeronutronic, Newport Beach, Calif.
STRENGTHS, WIDTHS, AND SHAPES OF THE LINES OF THE 3ν CO BAND
Darrell E. Burch and David A. Gryvnak 10 Mar. 1967 39 p refs
(Contract Nonr-3560(00); ARPA Order 237)
(U-3972; AD-657114)

Spectral curves of several CO samples were used to investigate the 3nu band whose center is near 6350/cm. The strength of the band for the common C12O16 isotope was found to be 0.0130 plus or minus 0.0005 atm/cm (STP)/cm. An empirical equation, Fm = 1 + 0.011 m was derived to account for the influence of vibration-rotation on line strengths. The half-widths of the self-broadened lines at 1 atm pressure vary from approximately 0.090/cm at an absolute value of m = 1 to 0.062/cm at an absolute value of m = 20. The widths of self-broadened lines are 1.08 plus or minus 0.005 times as great as N2-broadened lines at the same pressure. The Lorentz line shape appears to be appropriate for the collision-broadened lines within a few/cm of their centers; but the extreme wings of the lines are sub-Lorentzian.
Author (TAB)

N67-39068*# Monsanto Research Corp., Everett, Mass. Boston Lab.
TEST EVALUATION OF FUEL CELL CATALYSTS Quarterly Report, 16 May–15 Aug. 1967
S. Matsuda, B. P. Sullivan, and S. Polansky 20 Sep. 1967 10 p
(Contract NASw-1527)
(NASA-CR-89309; QR-2) CFSTI: HC $3.00/MF $0.65 CSCL 07D

During this period, the second group of compounds was tested for catalytic activity in the oxidation of N_2H_4. Some compounds showed very high activity in the oxidation of N_2H_4, although all compounds corroded in the test electrolyte solution. Selected catalysts from the first group were further examined for their characteristics on the N_2H_4 anode. The most interesting result was the extremely high NH_3 content in the gas evolved from these electrodes.
Author

N67-39088# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
CHEMICAL VAPOR DEPOSITION STATISTICAL PARAMETRIC STUDY
W. C. Robinson, F. H. Patterson, J. D. Fleming, and C. W. Gorton (Georgia Inst. of Technol.) Jul. 1967 24 p refs Presented at the Conf. on Chem. Vapor Deposition of Refractory Metals, Gatlinburg, Tenn., 12–13 Sep. 1967
(Contract W-7405-ENG-26)
(ORNL-TM-1890; CONF-670905-8) CFSTI: HC $3.00/MF $0.65

Factors affecting the chemical vapor deposition of W are evaluated in a statistically designed parametric study. Eighty-one experiments were required in the WF_6–H_2 deposition system to provide a third-order polynomial correlation between the response parameters and the independent system parameters over the experimental range of 450 to 820°C, 9 to 20 torr, 60 to 370 cm^3 WF_6 per minute, and 752 to 5240 cm^3H_2 per minute. The system parameters were H_2/WF_6 ratio, total flow rate, temperature, and pressure. The initial response parameters were determined for an internal deposit in a 15-in. length of a 0.807-in.-ID Cu mandrel. The application and limitations of utilizing the resulting curves for systems of different size and geometry are discussed. The deposition rate of W at HF mole fractions of 0.02, 0.05, 0.10, and 0.20 was also determined for each experiment and correlated with the system parameters.
Author (NSA)

N67-39096# National Bureau of Standards, Washington, D. C.
BIBLIOGRAPHY ON FLAME SPECTROSCOPY ANALYTICAL APPLICATIONS, 1800–1966
R. Mavrodineanu, comp.—Philips Labs. Washington, GPO, 23 Feb. 1967 163 p refs *Its* Misc. Publ.-281
GPO: $2.00

A collection of 5,113 references to works on flame spectroscopy, selected with emphasis on analytical measurements and covering the period from 1800 to 1966, is presented. The references are classified according to three categories: emission, atomic absorption spectroscopy, and electrical discharges having the aspect of combustion flames. References are arranged in alphabetical order by author. In some cases brief introductory comments and subject indexes are provided.
S.P.

N67-39124# Bureau of Mines, Bruceton, Pa.
EXPERIMENTAL STUDY OF PRESSURE DROP ACROSS FIXED BEDS OF ANTHRACITE BRIQUETS AND BLAST FURNACE MATERIALS
A. F. Baker, W. S. Sanner (Bur. of Mines, Pittsburgh, Pa.), R. F. Tenney (Bur. of Mines, Schuylkill Haven, Pa.), and J. W. Eckerd (Bur. of Mines, Morgantown, W. Va.) May 1967 32 p
(BM-RI-6945)

Pressure-drop studies were conducted in a 4-foot-diameter stimulated blast furnace shaft to compare anthracite metallurgical briquets with coke and formcoke. The test materials were used alone, layered, and in mixed burdens of commercial fuel-to-ore ratios. Anthracite briquets had a higher pressure drop per foot than furnace coke, but they had a lower pressure drop per foot than formcoke. This appears to be due to packing and shape, as well as the particle size. The superficial air velocities at which beds of briquets and furnace coke disrupted were about the same. However, if briquets of the shapes and sizes tested are substituted for

furnace coke in commercial metallurgical furnaces, higher blowing pressures will be required to deliver comparable amounts of air. Test burdens with more than 5 percent material smaller than 1/4-inch diameter showed significant increases in resistance to airflow. Author

N67-39133# Maryland Univ., College Park.
ON DIFFUSION AND ELECTRICAL CONDUCTIVITY OF ALKALI HALIDES Final Technical Report
Homer W. Schamp, Jr. [1967] 158 p refs
(Contract AT(40-1)-2068)
(TID-23874) CFSTI: HC $3.00/MF $0.65

Measurements of chloride ion diffusion in KCl were made in the pressure range between 7 and 17 kbars at three different temperatures: 685, 745, and 797°C. Isotherms for diffusion measurements at 685 and 745°C showed normal behavior with log D decreasing linearly with pressure. The activation volumes were computed to be 11.7±0.7 cm^3/mole at 685°C and 11.8±0.7 cm^3 mole at 745°C. The 797°C isotherm greatly differed from the other two. It is suggested that an increase in the diffusion coefficient in the vicinity of 17 kbars might be accounted for by the high pressure phase transition in KCl that occurred at 18 kbars. NSA

N67-39152# Combustion Engineering, Inc., Windsor, Conn. Nuclear Div.
VANADIUM PURIFICATION Quarterly Progress Report, Feb. 1–Apr. 30, 1967
V. S. Shen, S. Worcester, D. E. Mahagin and S. S. Christopher
May 1967 37 p refs
(Contract AT(30-1)-3742)
(CEND-3742-311) CFSTI: HC $3.00/MF $0.65

A 109 lb ingot of high purity V was processed by commercial melting techniques. Feedstock for the process was vanadium metal produced by aluminothermic reduction of V_2O_5. Two purification methods were employed: double electron beam melting; and double electron beam melting plus an intermediate, Y-doped arc melt. During processing, the metal's quality was determined by analyses of its chemical composition, hardness, and microstructure. In addition to a discussion of each stage of the ingot's production, an evaluation of the entire process is presented. Author (NSA)

N67-39201*# Kansas Univ., Lawrence.
INVESTIGATION OF ELECTROCALORIC EFFECTS IN FERROELECTRIC SUBSTANCES Final Status Report, 1 Mar.–31 Jul. 1967
31 Jul. 1967 27 p refs
(Grant NsG-575)
(NASA-CR-89302; SR-7)

Measurements of the electrocaloric effect and the static dielectric properties of crystalline tartaric acid were found to be quantitatively consistent with the generally-held idea that the pyroelectric effect is due to a large temperature dependent spontaneous polarization that is masked by conduction charges until it is changed by a temperature changed, and that the spontaneous polarization of a pyroelectric substance is somewhat like thatpof a erroelectric substance but is not reversible by an electric field. An equation of state and an expression for the Gibbs free energy for unstressed tartaric acid were deduced from the experiments. Author

N67-39219 Cekmece Nuclear Research Center, Istanbul (Turkey).
NEUTRON ACTIVATION ANALYSIS OF ROMAN COPPER COINS 250–600 A.D., PART II
Kurt Zuber May 1966 40 p refs
(CNAEM-35)

Tin can be detected in a copper coin by observing the 9.7 min. Sn-125 activity if epicadmium neutrons are used for the activation. Activation with epicadmium neutrons is also useful for the determination of indium. For cobalt the 5.1 y activity has to be observed if only traces are present. The problem of shielding is important for the activation by epicadmium neutrons. The observed experimental values of the calibration constants are compared with the values calculated by using the atomic and nuclear constants. The mass ratios of Ag, Au, Sn, Sb, Co and In to copper are given. The oldest coins show stronger alloying with silver and tin, whereas antimony is present up to nearly 1% in the younger coins. Gold is detected as an impurity of the silver used for the alloying. Cobalt is found in the coins minted under Constantine I and later. Indium was also detected as an impurity. In an appendix the measured values of the resonance integrals of three tin isotopes are given. Also the effective resonance integral of Cu-64 has been determined for 0.36–1.1 g/cm^2 copper. Author

N67-39291# Oak Ridge Operations Office, Tenn.
URANIUM HEXAFLUORIDE SPECIFICATIONS STUDIES: AN AEC PROGRAM STATUS REPORT
12 Jul. 1967 41 p refs
(ORO-656) CFSTI: HC $3.00/MF $0.65

The results of studies made by the Uranium Hexafluoride Specifications Study Committee are discussed. Recommendations are also included. Information is included on: need for specifications; current specifications for UF_6 delivered to the AEC; analytical procedures; formation of ^{232}U in power reactors; ^{232}U in gaseous diffusion cascades; formation and separation of transuranic elements; transuranic problem in the gaseous diffusion plants; sorption for removing impurities; and flow tests. NSA

N67-39297# Los Alamos Scientific Lab., N. Mex.
GAS-COLLECTION TECHNIQUE FOR MEASUREMENT OF FISSION-GAS RETENTION IN IRRADIATE $MoUO_2$ CERMETS
A. J. Patrick 12 Jul. 1967 6 p ref
(Contract W-7405-ENG-36)
(LA-3718) CFSTI: HC $3.00/MF $0.65

A method is described for determining the quantity of rare gas fission products retained in irradiated molybdenum–uranium dioxide cermet fuel specimens. Information concerning the location of the gas in the cermet structure was also obtained. The method utilizes differential dissolution of molybdenum from the cermet followed by the separate dissolution of the uranium dioxide. Cold-trap pumping of the gases liberated during boiling of the solutions enables a high percentage of the rare gases originally in the cermet to be collected in a sample can. Contents of the sample can are determined by mass spectrometric and gamma counting techniques. Author (NSA)

N67-39348* Scientific Translation Service, La Canada, Calif.
MASS-SPECTROMETRIC STUDY OF VAPORIZATION OF THE DIOXIDES OF ZIRCONIUM, HAFNIUM, AND THORIUM [MASS-SPEKTROMETRICHESKOYE ISSLEDOVANIYE ISPARENIYA DVUOKISEY TSIRKONIYA, GAFNIYA, I TORIYA]
S. A. Shchukarev and G. A. Semenov Washington, NASA, Oct. 1967 9 p refs Transl. into ENGLISH from the publ. "Issledovaniya v Oblasti Khimii Silikatov i Okislov", Moscow, Akad. Nauk SSSR, 1965 p 208–214
(Contract NASw-1496)
(NASA-TT-F-11306) CSCL 07B

Data on the composition of zirconium, hafnium, and thorium dioxide vapors are improved. The partial pressures of the vapor components are measured. Author

07 COMMUNICATIONS

Includes communications equipment and techniques; noise; radio and communications blackout; modulation telemetry; tracking radar and optical observation; and wave propagation. For basic research see: 23 Physics, General; and 21 Navigation.

N67-38060*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

EFFECTS OF DIELECTRIC COVERS OVER CROSS SLOTS IN A RECTANGULAR WAVEGUIDE

Marion C. Bailey (M.S. Thesis—Virginia Univ., Aug. 1966) Washington, NASA, Oct. 1967 47 p refs

(NASA-TN-D-4194) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The slot lengths were chosen so that the data cover the waveguide bandwidth for dielectric constants from 1 to 4. Slot locations were chosen so that the far-field radiation patterns would be circularly polarized near resonance. The formulations for the general inclined slot in a waveguide coupled to free space are extended to include slots radiating into an external medium of any dielectric constant. It is also shown that plane wave theory gives a bound on the variation of power radiated for dielectric covers thicker than one-fourth wavelength. In addition to providing a simple method for obtaining circular polarization with an ablative material, this study of cross slots gives a better insight into the effects of dielectrics over the general inclined slot in the broad wall of a rectangular waveguide. Author

N67-38069# Stanford Research Inst., Menlo Park, Calif.

A DEMONSTRATION OF THE CONSISTENT OPERATIONAL SUCCESS OF 2400 BAUD HF AUTODIN DATA TRANSMISSION USING THE CURTS PHASE II SYSTEM, PART I Final Report

John L. Ramsey, Karl D. Falperin, and Thomas I. Dayharsh Aug. 1967 67 p refs

(Contract DCA-100-67-C-0068)

(AD-657366)

The report describes an experiment that was conducted to evaluate the improvement in 2400-baud HF AUTODIN data transmission that can be realized when the CURTS (Common User Radio Transmission Sounding) Phase II Automatic Frequency Selection System is used to select communication frequencies on an operational 8000-km HF trunk. The following results were obtained: (1) The capability of HF to give consistent support to 2400-baud AUTODIN traffic was clearly established. (2) Use of the CURTS system improved the HF communication system performance both by increasing the average AUTODIN throughput from 92.7% to 97.4% and by reducing its standard deviation from 12% to 4.5%. CURTS therefore reduces the average number of AUTODIN cards lost per day from 21,900 to 7,800, or offers nearly a 3:1 improvement. (3) The most substantial improvement to HF communication can be made by evolving the effective and extensive frequency management techniques that CURTS makes possible. (4) The results of this experiment agree well with HF performance predictions made from evaluation of the CURTS data of the previous eight months. (5) Effective CURTS frequency management techniques would make the HF medium a viable alternative to other communication media. Author (TAB)

N67-38078# Stelma, Inc., Stamford, Conn.

FEASIBILITY STUDY, 19.2 KBS IN A 3 KHZ CHANNEL Final Report

Howard G. Robbins and Adrio L. Vannoni Aug. 1967 100 p ref

(Contract DCA-69)

(Rept.-0118; AD-657458)

The report describes a study to determine the feasibility of transmitting 19.2 kilobits per second through a schedule 48 line or TAT-2 submarine cable. The technique chosen for study was double sideband, quadrature suppressed carrier, amplitude modulation employing sixteen discrete levels of amplitude. The work performed included design and construction of a laboratory test model of the modem, and tests of the completed modem using various simulated line conditions. Typical of the results obtained in the study was an error probability of 0.005 at 14,400 bits per second at a 30db signal to noise ratio, and with delay simulation in the signal path. Transmission at 19.2 kilobits per second was not obtained, but with further work, as recommended in this report, transmission at 9.6Kb, at an error rate of 0.00001 and possibly 14.4Kb at an error rate of 0.006 is feasible. Author (TAB)

N67-38091*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

INPUT ADMITTANCE OF A RECTANGULAR WAVEGUIDE-FED APERTURE ANTENNA RADIATING INTO AN INHOMOGENEOUS LOSSY DIELECTRIC SLAB

Calvin T. Swift Washington, NASA, Oct. 1967 32 p refs

(NASA-TN-D-4197) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The input admittance of a rectangular waveguide opening onto a perfectly conducting ground plane and covered with an inhomogeneous dielectric slab is formulated as a boundary value problem. As a specific application of the solution, a plasma slab is considered. In the calculations, the plasma is assumed to be homogeneous except in the vicinity of the ground plane, where a local boundary layer of electron density occurs. Two ranges of collision frequencies are selected, and calculations are performed for the input admittance as a function of peak electron density and boundary-layer thickness. The numerical results show that a small boundary-layer reduction of electron density near the ground plane can significantly influence the input admittance of the antenna and causes a substantial lowering of the voltage reflection coefficient when the plasma is overdense. Author

N67-38126# Environment Science Services Administration, Boulder, Colo. Inst. for Telecommunication Sciences and Aeronomy.

HEIGHT GAIN, LOCATION GAIN, AND CORRELATION IN IRREGULAR TERRAIN AT 20, 50, and 100 MHz

A. P. Barsis and M. J. Miles Apr. 1967 69 p refs

(IER-35-ITSA-35; AD-655001) CFSTI: HC $3.00/MF $0.65

Results on height gain, location gain, and correlation are presented which are based on data obtained from a comprehensive measurement program in irregular terrain at frequencies of 20, 50, and 100 MHz. Specifically, it was found that height gain, but not location gain, is independent of path distance for transmission paths up to 80 km long. Location gain is defined as the reduction in transmission loss obtainable by a search within a 100-m radius of a nominal receiving point. The measurement program permitted simulation of the interaction between net and relay type communication links by simultaneous recordings of signals received from a test station with low transmitting antenna height, and a commercial frequency modulation broadcast station (not co-located) with a high transmitting antenna. It was found that the correlation coefficient between transmission loss values from the two sources is close to unity when the transmission paths have a small angular separation, but decreases with increasing angle between transmission paths. Author (TAB)

N67-38146# Environmental Science Services Administration, Boulder, Colo. Institute for Telecommunication Sciences and Aeronomy.

TABULATIONS OF VHF PROPAGATION DATA OBTAINED OVER IRREGULAR TERRAIN AT 20, 50, AND 100 MHz

M. E. Johnson, M. J. Miles, P. L. McQuate, and A. P. Barsis May 1967 401 p refs

(IER-38-ITSA-38; AD-655854)

The report contains tabulations of transmission loss data resulting from propagation experiments at 20, 50, and 100 MHz conducted over irregular terrain in the Colorado high plains east of the Continental Divide. Although analysis results have already been described in several unpublished reports and in papers by Miles and Barsis (1966) and Barsis and Miles (1967), it seems appropriate to present a complete compilation of all data obtained in this program together with other pertinent information. In this way, additional analyses for specific purposes will be facilitated. TAB

N67-38152# Aerospace Corp., El Segundo, Calif. Technical Operations.

HISTORICAL ANALYSIS OF ELECTROMAGNETIC INTERFERENCE LIMITS

C. B. Pearlston, Jr. Apr. 1967 51 p refs

(Contract AF 04(695)-1001)

(TR-1001(2307)-12; SSD-TR-67-127; AD-657014)

Limits currently used by military specifications for control of electromagnetic interference and susceptibility are uniformly based on tests which were conducted many years ago on aircraft voice communication equipment in typical aircraft installations, and do not necessarily relate to present requirements of space systems. This paper examines the development of interference and susceptibility limits in various military specifications indicating the technique by which the limits were derived, the rationale for such derivation, and the changes in various limits with time since their original formulation. It also discusses certain inconsistencies within and between the limits of the various specifications. The evaluation of the status of this field practically dictates that a study should be initiated to realistically formulate a theoretically and empirically valid set of interference and susceptibility limits to fit the needs of modern, complex systems in crowded, electromagnetic enviroments. Author (TAB)

N67-38235*# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

APOLLO TELEMETRY FRAME SYNCHRONIZATION TECHNIQUES

T. W. Coleman and J. W. McIntyre May 1967 71 p refs

Sponsored in Part by NASA

(Contract NOw-62-0604-c)

(NASA-CR-89203; TG-917; AD-656890) CSCL 09F

An analysis has been made of data frame synchronization control for Apollo downlink telemetry. The basic objective was to determine the effects of varying the switch-controlled error tolerance thresholds of two types of existing operational equipment. Criteria for setting these error tolerance switches are presented. The criteria are established to control the average time spent in the acquisition and lock modes of the data decommutation process. Any choice of switch settings would be dependent upon the data quality and quantity requirements of a particular mission. Examples of switch setting criteria are given which depend upon maximum acceptable bit error rates based on assumed operational requirements. Author (TAB)

N67-38266# Navy Electronics Lab., San Diego, Calif.

EFFECT OF OFF-PATH IONOSPHERIC REFLECTIONS ON VLF RADIO WAVES Research Report, Jan. 1966–Apr. 1967

E. E. Gossard and M. R. Paulson 14 Jun. 1967 44 p refs

(NEL-1467; AD-657172)

Describes a technique for analyzing movements in the lower ionosphere. The technique uses a ground based very-low-frequency radio transmitting and receiving system. The experimental results show that off-path reflections in the irregular ionosphere are much more important than hitherto believed, and that movement of discrete reflectors in the ionosphere causes Doppler frequency shifts that have an important effect on the phase and amplitude fluctuations of reflected radio waves. Author (TAB)

N67-38306# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.

PARAMETRIC AMPLIFIER INTERIM WEATHER FIX Final Report

William F. Herget and Domenick L. Offi Jul. 1967 23 p

(RD-67-41; AD-657118)

Two methods of reducing the effects of the parametric amplifier on weather clutter were investigated. The first method involved turning off the parametric amplifier during periods of severe weather. The second method provided for RF attenuation at the receiver input. The first method was rejected primarily because it did not lend itself to remote control from the operators position. The second method fully met all immediate requirements and was recommended as a satisfactory, interim solution. Author (TAB)

N67-38328# Syracuse Univ. Research Inst., N. Y. Electrical Engineering Dept.

OPTIMUM SPATIAL PROCESSING IN A NOISY ENVIRONMENT FOR ARBITRARY ANTENNA ARRAYS SUBJECT TO RANDOM ERRORS

David K. Cheng and Fung-I Tseng 15 May 1967 44 p refs

(Contract AF 19(628)-5668)

(SR-3; AFCRL-67-0310; AD-653212) CFSTI: HC$3.00/MF$0.65

The report presents a procedure for the maximization of the expected signal-to-noise ratio improvement factor for arbitrary antenna arrays whose excitation amplitudes and phases as well as element positions are subject to random errors. The formation in its general form imposes no restrictions on either the probability distribution or the variance of the random errors. Correlations are allowed to exist between the random variations in array parameters, and the effect of system internal noise is considered. Computed results for a linear, endfire array in a typical noise environment are given which illustrate the dependence of the expected value and the standard deviation of the signal-to-noise ratio improvement factor on the system internal noise, the system bandwidth, the amplitude, phase and position errors, and the error correlation intervals. Typical expected power pattern functions are also plotted. Author (TAB)

N67-38351# Naval Research Lab., Washington, D. C.

EXPERIMENTAL STUDIES OF MICROWAVE FERRITE COMPONENTS. PART I: FERRITE LOADED SERIES FEED SYSTEM FOR PHASED ARRAYS. PART II: E-PLANE PARALLEL PLATE WYE-CIRCULATOR

W. H. Mendenhall, Jr. May 1967 24 p ref

(NRL-MEMO-1777; AD-654902)

CONTENTS:

1. FERRITE LOADED SERIES FEED SYSTEM FOR PHASED ARRAYS, PART I p 1–14 refs (See N67-38352 23-07)

2. E-PLANE PARALLEL PLATE WYE-CIRCULATOR, PART II p 15–22 refs (See N67-38353 23-07)

N67-38352# Naval Research Lab., Washington, D. C.

FERRITE LOADED SERIES FEED SYSTEM FOR PHASED ARRAYS, PART I

In its Exptl. Studies of Microwave Ferrite Components. Part I and Part II May 1967 p 1–14 refs (See N67-38351 23-07)

This report describes the results of a study to determine if rf coupling from a ferrite loaded waveguide to an empty secondary waveguide can be employed as a series feed system for an electronically scanned phased array antenna. A fixed frequency of 9.375 Gc was used. Two classes of reciprocal phase shift ferrite configurations were studied; one class employed broadwall coupling and the other class employed sidewall coupling. The various ferrite configurations were evaluated by observing the variation of phase shift per inch (ϕ) and coupling coefficient (k) as a function of longitudinally applied magnetic field. Design goals which these quantities (ϕ and k) should satisfy were specified from fundamental array considerations. Some factors which influence ϕ and k were determined. Two configurations which will work in principal were found, but neither is considered practical because of low values ϕ and k. Author

N67-38383# Naval Research Lab., Washington, D. C.
E-PLANE PARALLEL PLATE WYE-CIRCULATOR, PART II
In its Exptl. Studies of Microwave Ferrite Components. Part I and Part II May 1967 p 15–22 refs (See N67-38351 23-07)

This report describes a study undertaken to determine the feasibility of developing a ferrite wye-circulator in a parallel plate E-plane wye. Several preliminary ferrite configurations were observed. Circulation of the rf power was achieved using a pseudo waveguide configuration in the wye junction. Isolation as high as 15 db was observed although the junction was poorly matched. Author

N67-38393# Navy Underwater Sound Lab., New London, Conn.
TWO FORTRAN PROGRAMS (0577 AND 0717) FOR COMPUTING ELECTROACOUSTICAL BEHAVIOR OF TRANSMITTING SONAR ARRAYS
David T. Porter 15 Jun. 1967 45 p refs
(USL-791; AD-656913)

The Underwater Sound Laboratorys FORTRAN Programs 0577 and 0717 compute the steady-state electrical, mechanical, and acoustical behavior of transmitting sonar arrays. These programs, which have considerable flexibility, are able to accommodate up to three different arrays on the same baffle; and, since the transducers in these arrays need not be identical, stagger-tuned arrays can be used. The arrays may be mounted on rigid planar, cylindrical, or spherical baffles. Based on the transducer characteristics that are read in as input data, Programs 0577 and 0717 compute an equivalent circuit and from it a Thevenin-equivalent circuit. Pritchards mutual impedance formula is used to compute a mutual impedance matrix. The transducer driving forces are generated from the given amplifier data; knowledge of the equivalent circuit; and the phasing, steering, and sheding to be used. Depending on the size of the array, the transducer face velocities are computed from the equations relating them to the driving forces and mutual impedance matrix either by direct matrix inversion (Program 0577) or an iterative patch method (Program 0717). Then the radiation impedances, electrical input impedances, and electrical powers, currents, voltages, efficiency, etc., can be computed. The farfield pressure pattern and source level are determined by the face velocities and appropriate element directivity patterns. The directivity index is obtained from knowledge of the source level, total electric power, and efficiency. A plan is given for a more detailed analysis of a transmitting array, including its sonar dome. The analysis would be done by six computer programs run sequentially. Author (TAB)

N67-38523# Institute for Defense Analyses, Arlington, Va. Research and Engineering Support Div.
A SECOND MOMENT EXPONENTIAL ERROR BOUND FOR PEAK LIMITED BINARY SYMMETRIC COHERENT CHANNELS AT LOW SNR
Joseph M. Aein Jul. 1967 45 p refs
(Contract DAHC15-67-C-0011)
(P-341; IDA/HQ-67-6201; AD-657187)

An exponential-type bound on error rate, Pe, for peak limited binary coherent channels operated at low SNR is presented. The bound depends exponentially only on the first and second moments of the channel output and serves to justify, in part, the use of SNR calculations for error rate performance. It is assumed that the receiver output, V, is given by a simple sum of n(=(TW)) identically distributed, independent random variables w sub i, each of which is decomposable into the sum of two independent random variables, z sub i and eta sub i, i.e., w sub i = z sub i + eta sub i. The z sub i are peak-limited by B sub z, numerical value of z sub i < or = B sub z, whereas eta sub i are normal (0, sq sigma). The z sub i represent the output of a peak-limited channel and the eta sub i represent any post channel receiver thermal noise (which may be zero, sq sigma = 0). For example, the z sub i may represent the output of a bandpass limited satellite repeater, with an interference input in addition to the desired signal, and eta sub i the front-end noise in a receiving ground station. Author (TAB)

N67-38633* ITT Federal Labs., Nutley, N. J.
ANALYTICAL STUDY OF THE NEED OF FREQUENCY AND TIME Final Report
[1965] 72 p refs
(Contract NAS5-9715)
(NASA-CR-88990) CSCL 17B

The purpose of this study has been to determine the present and future needs of the NASA for stable time and frequency standards. The study consisted of an investigation into the various communication and tracking systems employed by the NASA in carrying out their mission, an attempt to convert system characteristics into requirements for time and/or frequency, and a validation of the time and frequency needs specified by engineers and scientists. The methods employed in acquiring this data included questionnaires, interviews, literature search, in-house consultation, contract review, analysis of current equipment usage, and a survey of theoretical limitations on range and range-rate systems. However, no single method proved outstanding as a means for obtaining data pertinent to the study. Of particular interest is a survey made on the theoretical limitations on range and range rate systems in which errors in range and range rate systems are related to oscillator stability characteristics. Author

N67-38852# Naval Research Lab., Washington, D. C.
THE RANDLE CLIFF RADAR DIGITAL RANGE-MEASURING INSTRUMENT Final Report
Phillip L. Watkins and Frank D. Clarke 19 Jul. 1967 35 p
(NRL-6572; AD-657306)

The Randle Cliff Radar (RCR) facility at the NRL Chesapeake Bay Division, which employs a 150-ft-diameter steerable antenna, uses digital data-acquisition techniques. In a complex of digital instrumentation, one instrument incorporates several noteworthy and unique features. The Digital Range-Measuring Instrument(DRAMI) is a multiple-mode radar-range digitizer. Though basically a gated-pulse counter capable of continuous readout of range information in either binary of BCD form, the DRAMI is unique in that unambiguous target range measurements are obtainable to a maximum range of 100,000 naut mi plus or minus 0.1 naut mi), even though the target lies beyond a number of radar interpulse periods. Another feature permits the accumulation, prior to readout, of several successive radar range values. The values are stored in

the DRAMI register until a readout command is received, at which time display and recording are accomplished. Still another feature is the Test mode of operation, in which all commands are internally generated and the DRAMI is, in a sense, made to check itself. In the event of improper operation, several key signals can be manually generated from the front panel, thus permitting the operator to pinpoint technical difficulties. The DRAMI is a versatile, reliable, and accurate device. It was specifically developed for use with the RCR system in order to facilitate range studies of fast-moving or distant targets. However, the principles of its operation can be applied to meet the needs of any radar system. Author (TAB)

N67-38559# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
PHASED ARRAY ANTENNA DEVELOPMENT
J. Frank Mar. 1967 178 p refs
(Contract NOw-62-0604-c; Proj. Defender)
(TG-882; AD-656888)

The ability to rapidly scan a highly directive antenna beam has been made possible by recent advances in the art of microwave phase shifting. This report describes an experimental C-band phased array antenna. The antenna is composed of eight subarrays which may be arranged in several configurations to investigate the effects of a full array. Each subarray contains a reactive power divider, 48 ferrite phase shifters and their electronic drivers, and a radiating structure. The radiating structure has been designed to provide some compensation for impedance variation with scanning. The design and fabrication of the components are discussed in detail, and test results of the array are presented and analyzed. Author (TAB)

N67-38565# Bolt, Beranek, and Newman, Inc., Cambridge, Mass.
SPEECH COMMUNICATION INDEX METER: FURTHER APPLICATIONS AND IMPROVEMENTS Final Report
Michael H. L. Hecker, Gottfried von Bismarck, and Carl E. Williams Bedford, Mass., AFSC, Electronic Systems Div., 26 Jul. 1967 87 p refs
(Contract AF 19(628)-5874)
(BBN-1481; ESD-TR-67-516; AD-656788)

To study the feasibility of using the Speech Communication Index Meter (SCIM) to evaluate time-varying communication systems, recordings were made of the transmission characteristics of a troposphere-scatter system. At many specific points in time in these recordings, Articulation Indexes were calculated and intelligibility scores were obtained from listeners with the aid of a special test procedure. For most points, the intelligibility score could be reasonably well predicted from the Articulation Index. This finding was interpreted as indicating that SCIM is potentially capable of evaluating time-varying systems. In a second study, SCIM was used to predict the intelligibility of peak-clipped speech. For a wide range of signal-to-noise ratios and clipping levels, the performance of SCIM was compared with intelligibility test results reported in the literature. After a minor modification, SCIM computed reliable SCIs which could be related to the published intelligibility data. This study demonstrated that SCIM could accurately evaluate communication systems employing peak clipping. SCIM was also modified to reduce the computation time, and to improve the synchronization between the signal generator and the analyzer. In addition, various other circuit changes were implemented to improve the performance of SCIM. TAB

N67-38598*# International Business Machines Corp., Rockville, Md. Federal Systems Div.
SPECIAL AROD SYSTEM STUDIES, VOLUME 2
15 Jan. 1965 51 p refs
(Contract NAS8-11050)
(NASA-CR-89259; IBM-TR-15-7; QR-5) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The appendices to special Airborne Range and Orbit Determination (AROD) system studies on wideband modulation techniques and a phase locked loop advanced circuit are presented. They include the range equation, phase lock loop, signal spectrum, and pseudonoise analyses. R.N.A.

N67-38638*# Electronic Engineering Co. of California, Santa Ana.
TIME CODE STUDY Semiannual Report, 15 Sep. 1964–28 May 1965
15 May 1967 168 p
(Contract NAS5-9739)
(NASA-CR-85359; SAR-1) CSCL 09F

The time code study presents a survey and analysis of the techniques used in time code generation, recording, decoding, transmission, and distribution, with particular attention given to the time code formats used. An analysis of time code characteristics is presented in terms of the time code formats which are in general use. Author

N67-38648# Dayton Electronic Products Co., Ohio.
ELECTRICALLY-SMALL, SUPERCONDUCTING ANTENNAS Final Report, 1 Mar. 1966–28 Feb. 1967
Bernhard M. Schmidt Apr. 1967 152 p refs
(Contract AF 19(628)-5893)
(AFCRL-67-0200; AD-657376)

The advantages and limitations of electrically-small, superconducting antennas were investigated. The study led to a consideration of miniaturization, physical shape factors, long range magnetic coupling, maximum signal levels, antenna-receiver interface problems, materials, structures, and potential antenna applications of the quantum effects in superconductors. In addition, natural cooling and superdirectivity were incidental but relevant topics. In general, it was found that the possibility for miniaturization represents the principal advantage of the superconducting antenna, especially at the lower frequencies where antennas often are electrically-small through physical necessity. Radiation efficiency is increased in transmitting antennas, but at the expense of bandwidth. The degree of usefulness of superconductivity in receiving antennas depends considerably on the low noise properties and input impedance of the receiver and on the environment of the antenna. Any cooling improves the performance of the antenna; in fact, except in the case of the perfect receiver, there is some question as to which is more effective, the low temperature or the superconducting mode. Author (TAB)

N67-38701# Hughes Aircraft Co., Fullerton, Calif.
INVESTIGATION OF USE OF SUPERIMPOSED SURFACE WAVE MODES, PART II Final Report, 1 Feb. 1966–31 Jan. 1967
N. S. Wong and R. Tang 28 Feb. 1967 103 p refs
(Contract AF 19(628)-4984)
(FR-67-14-151, Pt. II; AFCRL-67-0171; AD-657289)

A novel method of achieving a matched radiating element in a phased array antenna over a wide scan angle has been investigated. This method has been applied in the design of an experimental linear array of 41 elements. Each radiating element consists of an open-ended waveguide driven by an end-on coaxial transition in conjunction with offset posts for the appropriate excitation of the two lowest order modes. The measured input VSWR over a 55 degree scan angle was less than 1.5 on this experimental linear array. This result agreed fairly well with the predicted value. In addition, no degradation on the array pattern due to edge effect was observed on the experimental array with all the elements matched over the 55 degrees scan range. Author (TAB)

N67-38711*# Harvard Univ., Cambridge, Mass. Gordon McKay Lab.
THE ELECTRICALLY LONG ANTENNA CURRENT, ADMITTANCE AND FAR FIELD
Ronold W. P. King and Sheldon S. Sandler Aug. 1967 26 p refs
(Grants NsG-579; NSF GK-273)
(NASA-CR-89342; SR-9) CFSTI: HC $3.00/MF $0.65 CSCL 09F

An approximate formula is derived for the distribution of current in and the driving point admittance of electrically long and thin dipole antennas. It consists of four terms to represent the real and four terms to represent the imaginary part of the current referred to the driving voltage. These combine simple sines and cosines for the leading parts with linearly and logarithmically tapered sines and cosines to shape the amplitudes. The currents per unit voltage at the driving points give the admittance. Author

N67-38859* Electronic Engineering Co. of California, Santa Ana.
TIME CODE STUDY Final Report, 15 Jun. 1964–6 Jun. 1966
6 Jun. 1966 71 p refs
(Contract NAS5-9739)
(NASA-CR-89261) CSCL 09F

The second phase of a time code study is presented which surveys the time code generation and timing distribution techniques used in tracking stations and missile test ranges. The subsystems at these facilities are classified and categorized in accordance with their types and functions. The characteristics of the time code generation systems and the radio and wire distribution systems at the various test facilities are tabulated. R.N.A.

N67-38930# Ohio State Univ., Columbus. ElectroScience Lab.
RESEARCH INTO THE SCATTERING OF ELECTROMAGNETIC ENERGY FROM HIGHLY CONDUCTING BODIES Final Report, 1 Mar. 1964–28 Feb. 1967
E. M. Kennaugh, D. L. Moffatt, and R. C. Schafer 24 May 1967 56 p refs
(Contract AF 19(628)-4002)
(Rept.-1793-4; AFCRL-67-0329; AD-657356)

The report summarizes research during the period March 1, 1964, to March 1, 1967, under Contract AF 19(628)-4002, on the subject: Scattering of Electromagnetic Energy from Highly Conducting Bodies. The purpose of this research is to improve theoretical methods for the analysis of scattering problems involving arbitrary transient electromagnetic fields and to apply such methods to specific scattering shapes. The report is contained in three sections. In Section I, the transient response of finite bodies at great distances is discussed. An incident plane electromagnetic wave of impulse, step, or ramp function time-dependence is incident upon an object, and the time-dependent waveforms scattered in various directions are of interest. The approximation of these waveforms by several methods is considered, as well as the interpretation and further uses of the waveforms, when determined. Section II is concerned with the near-zone behavior of the transient electromagnetic fields for the same forms of plane wave illumination. Theoretical techniques for approximating the waveforms associated with particular components of the electromagnetic field on the surface of a conducting scatterer are investigated and compared with exact or numerical solutions in specific cases. Section III discusses experimental techniques for investigating the scattering of transient plane waves by objects. In particular, the use of continuous-wave reflection-measuring systems at a number of harmonically related frequencies to estimate the ramp response waveform of simple objects is considered. Author (TAB)

N67-38957*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A GUIDE TO CONSTRUCTION OF INEXPENSIVE AUTOMATIC PICTURE-TRANSMISSION GROUND STATIONS
Charles H. Vermillion Sep. 1967 74 p refs
(NASA-TM-X-55957; X-730-67-240) CSCL 09F

Functions of an automatic picture transmission (APT) equipped satellite are summarized. Circuit descriptions, operating procedures, and material and cost requirements for assembling an APT ground station are described. Station elements considered include antenna configuration, FM VHF receiver, facsimile, tape recorder, and camera. Electronics parts listings and circuit schematics for most of the system are given. A preliminary block diagram is also included for a direct readout infrared (DRIR) for handling data from weather satellites equipped with infrared equipment. E.C.

N67-39032 Joint Publications Research Service, Washington, D. C.
PROPAGATION OF LONG AND SUPERLONG RADIO WAVES IN THE EARTH-IONOSPHERE WAVEGUIDE CHANNEL
S. T. Rybachek and E. M. Gyunninen 9 Oct. 1967 13 p refs
Transl. into ENGLISH from Probl. Diffraktsii i Rasprostraneniya Voln (Leningrad), v. VI, no. 5, 1966 p 115–124
(JPRS-42898; TT-67-33524) CFSTI: $3.00

The radio propagation problem is investigated using the method of resolution by normal waves, involving the calculation of the Hankel function with integral Sommerfeld representations. Integration is performed by contours close to the contours of most rapid descent, and a system of two transcendental equations is derived. The relationship of the attenuation and phase velocity of the waveguide mode with the field frequency and properties of the ionosphere is discussed. A comparison of results is made with those from the multiply-reflected wave or beam method. N.E.N.

N67-39091*# Ohio State Univ., Columbus. ElectroScience Lab.
SCATTERING FROM SURFACES WITH DIFFERENT ROUGHNESS SCALES: ANALYSIS AND INTERPRETATION
William H. Peake and Donald E. Barrick 15 Sep. 1967 68 p refs
(Grant NsG-213-61)
(NASA-CR-89320; TR-1388-26) CFSTI: HC $3.00/MF $0.65 CSCL 20N

Average incoherent scattering cross sections for slightly rough surfaces are obtained using a perturbation technique for a perfect conductor, and for a surface material which is homogeneous (with variable permeability, μ_r, as well as permittivity, ϵ_r). The results, correct to the first order, include polarization dependence, and particular solutions with curves are presented for the vertical, horizontal, and circular states. Three optics techniques yielding results for very rough surface scattering cross sections are presented, and it is shown that they all give the same solution for Gaussian surfaces. Both homogeneous and perfectly conducting surface materials are treated, and polarization dependence is preserved. Surfaces consisting of both very rough and slightly rough structures together, termed composite surfaces, are analyzed, and an heuristic physical derivation of their scattering cross section is presented. Average backscattering cross sections for rough spherical surfaces are presented. Both the coherent and incoherent cross sections are given for slightly and very rough spheres. Author

N67-39092*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INTERCOMPARISON OF COLLOCATED LASER OPTICAL AND GRARR RADIO RANGING SYSTEM TRACKS ON GEOS-A

John H. Berbert, Paul Maresca (RCA Service Co.), Patrick Norris (RCA Service Co.), and Robert Reich (RCA Service Co.) Sep. 1967 38 p refs
(NASA-TM-X-55950; X-514-67-447) CFSTI: HC $3.00/MF $0.65 CSCL 17I

NASA is conducting a Geodetic Earth Orbiting Satellite-A (GEOS-A) Observation Systems Intercomparison Investigation. As part of this investigation, some tests consisted of side-by-side tracking of the GEOS-A spacecraft by the Goddard Range and Range Rate (GRARR) system and the Goddard Laser tracking system. Seventeen passes were observed from July to November 1966 by the Rosman, North Carolina GRARR station and 10 of these were evaluated. In the investigation, the Laser system tracks of the spacecraft were used as a reference trajectory for the GRARR system. The Laser data was smoothed using the GEOS-A Data Adjustment Program (GDAP) giving a reference orbit at the selected time of epoch in the form of a cartesian position and velocity vector. The evaluation of data shows that Laser orbits can be used to detect systematic errors in both range and range rate to about 2 meters and 1 centimeter per second respectively. Author

N67-39125*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.
PERFORMANCE ANALYSIS OF THE APOLLO UNIFIED S-BAND AND COMMUNICATIONS SYSTEM FOR A TYPICAL LUNAR MISSION
C. T. Dawson, G. D. Arndt, and R. W. Moorehead 1 May 1967 134 p refs
(NASA-TM-X-60440; MSC-EB-R-67-1) CSCL 17B

In order to define the conditions under which the Apollo unified S-band system will provide adequate communications during a lunar mission, a time-line of expected communication performance, based on a typical lunar mission trajectory, is calculated and graphically presented. Results indicate that the following modes have negative margins at lunar distance under worst case conditions: (1) two phase modulation (PM) contingency modes, Command Service Module (CSM) Mode 8 and Lunar Module (LM) Mode 4, which have simultaneous low bit rate telemetry and backup voice and which are to be used when the high gain antenna is not available; and (2) three frequency modulation (FM) modes (CSM Modes 1 and 2 which have playback noise and telemetry, and CSM Mode 4 with television). All other FM and PM modes, when used in the normal antenna and power configuration, have positive circuit margins throughout the mission. Circuit margins for required CSM and LM up-link modes are positive except for simultaneous transmission of up-data and voice to the LM at lunar distances when using the omni antenna. R.N.A.

N67-39161*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
INTERCOMPARISON OF GEOS-A OBSERVATION SYSTEMS
John H. Berbert Jul. 1967 21 p refs
(NASA-TM-X-55945; X-514-67-315) CFSTI: HC $3.00/MF $0.65 CSCL 17I

The current status of NASA's Geodetic Satellite Observation Systems Intercomparison Investigation is presented. A number of accurate short orbital arcs (1/4 orbit) were determined with tracking data from the GEOS-A satellite tracking systems. Types of systems included were the NASA Goddard Range and Range Rate (GRARR), Laser and MOTS camera systems, the Army Sequential Collation of Range (SECOR) system, the Navy Tranet doppler system and the Air Force PC-1000 camera. Error model coefficients derived for the various systems include zero-set bias, timing bias, and refraction anomaly. These are determined to an accuracy better than the 10 meter goal of the investigation. Random noise estimates for these data were also determined. The Short Orbital arc technique of intercomparison is shown to give results consistent with intercomparisons of data from collocated Laser and GRARR systems at Rosman, North Carolina. Author

N67-39168 European Space Vehicle Launcher Development Organization, Paris (France).
A NOISE MODEL FOR SIMULATING THE EFFECT OF TROPOSPHERIC TURBULENCE ON MEASUREMENTS OF RANGE, RANGE RATE, ANGLES AND ANGULAR RATE ASSOCIATED WITH RADIO GUIDANCE AND TRACKING STATIONS
R. Cosaert Aug. 1967 27 p refs Presented at the IFAC Symp., Vienna, Sep. 1967
(ELDO-TM-F-4)

The noise model prescribed enables simulation of noise due to tropospheric turbulence on both analogue and digital computers. It is also tailored for synthesis of optimum filters based on a least-square-fit, the Kalmann–Wiener–Bucy theory and other minimum variance methods. Author

N67-39228* Rensselaer Polytechnic Inst., Troy, N. Y.
A DIGITAL COHERENT MEMORY FILTER FOR SATURN V BENDING MODE IDENTIFICATION Final Report
Brian Hendrickson Aug. 1967 64 p refs
(Grant NGR-33-018-014)
(NASA-CR-89319) CSCL 09F

It is the intent of this paper to discuss the merits of a digital coherent memory filter as a low frequency spectrum analyzer; the specific application studied is bending mode isolation in a Saturn V/S-IC booster. From the general analog coherent memory filter, a digital system is derived, fully capable of isolating frequencies as low as .8Hz to within 5%. As a means of substantiating the method of approach, the design is simulated with the aid of a digital computer. To illustrate the behavior of the coherent memory filter in noise, uncorrelated, additive, gaussian noise is introduced by a random number generating subroutine. From these results, specifications for hardware implementation may be predicted. Author

N67-39233# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EXPERIMENTAL SETUP FOR THE SYNTHESIS OF SPEECH SEGMENTS [EKSPERIMENTAL'NAYA USTANOVKA DLYA SINTEZA OTREZKOV RECHI]
L. B. Belozerova 31 Jan. 1967 25 p refs Transl. into ENGLISH from Tr. Inst. Elektron., Avtomatiki i Telemekhaniki (Ukrania), v. 4 1963 p 51–66
(FTD-HT-66-469; TT-67-62355; AD-655346)

The report describes an experimental setup for synthesizing speech for the purpose of accumulating data on the structural make-up of the discrete units of language and of determining the technological demands made on such devices. The stream of speech at the synthesizing end of the system is regenerated under the immediate control of the portion of information abstracted from the speech of the announcer. As applied to reading and translating machines the problem of synthetic speech appears in a somewhat different form: sufficiently intelligible artificial speech must be created anew from the semantic information obtained in the reading or translation of some text. A block-diagram is given whose principal components are a sound power source, unit for forming a statistical formant spectrum, units for formant variation, automatic starter for voicing the synthesized speech segment, delay block, electronic commutator for pauses between sounds, electronic channel commutators, device for shaping the synthesized speech segment, and final amplifier. The described device synthesized separate phonemes, words, and syllables of Georgian. Videograms of synthesized speech segments and brief engineering data on the individual components of the setup are given. TAB

N67-39237 European Space Vehicle Launcher Development Organization, Paris (France).
SENSITIVITY ANALYSIS OF MODERN OPTIMUM FILTERING METHODS TO UNKNOWN MODEL PARAMETERS
R. Cossert and E. Gottzein Aug. 1967 22 p refs Presented at the IFAC Symp., Vienna, Sep. 1967
(ELDO-TM-F35)

A decoupled shifting memory filter method, which is tailored for radio tracking of both boosted and ballistic phases of flight of space vehicles, is presented. The method is compared with conventional recursive Kalman–Bucy–Wiener filters and least square fit filters and relative merits are analyzed. The new method is particularly suited for sensitivity analysis to unknown model parameters. Author

N67-39267# National Center for Atmospheric Research, Boulder, Colo.
ELECTRONICS FOR AROUND-THE-WORLD GHOST BALLOON FLIGHTS
Ernest W. Lichfield and Robert W. Frykman *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 59–67 (See N67-39251 23-02)

The electronic components and packaging are briefly described and circuit diagrams are presented. The components mentioned include the 28-solar-cell power supply, small sun-angle sensor, Morse code circuit, 15 MHz band transmitter, and antenna. The ground tracking operations and the four-channel telemetry system are outlined. N.E.N.

N67-39295# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.
EVALUATION OF A HIGH-GAIN VHF/UHF COMMUNICATION FACILITY Final Report
Lloyd Pearson Jul. 1967 24 p
(RD-67-48)

This report presents the results of tests performed on the FAA High-Gain VHF/UHF Communications System established in Hawaii to provide increased communications range coverage for air-traffic operating between Hawaii and the U. S. west coast. Observations on tests performed by the antenna contractor, to determine characteristics of the antenna system are also presented. Descriptions of the high-gain communications system and the instrumentation and procedures used for the test effort are provided. The results of the down range flight test indicated that the high-gain communications facility will extend communications range by as much as 68 percent as compared to that provided by the existing FAA RCAG facility. Results of tests performed by the antenna contractor on the communications system indicated that the antennas are generally within design specification. Based on results of the tests, it was concluded that the communications system was acceptable for commissioning to service. Author

N67-39314* Motorola, Inc., Scottsdale, Ariz. Military Electronics Div.
S-BAND TRANSPONDER, MARK I 20-CYCLE BANDWIDTH Final Report
Warren Dahl and B. Mathes 31 Jul. 1964 242 p
(Contracts NAS7-100; JPL-950413)
(NASA-CR-89080; WF-2840) CSCL 09F

A detailed description of the transponder system and modules, procedures for alignment and testing, and a bibliography listing the specifications, drawings, and other pertinent data are presented. The transponder is contained in a single 14-pack housing, but the design is adaptable to multiple 6-pack configurations making possible the use of a redundant transmitter for increased reliability. A multiple 6-pack configuration of this transponder was produced for the Mariner C program. The design provides the functions of a command receiver, a phase-coherent ranging transponder, and a telemetry transmitter. The transponder consists of a double-conversion, phase coherent receiver and a CW transmitter integrally related in both frequency and phase. The receiver has a minimum threshold sensitivity of −150 dbm. The transmitter is a solid state design utilizing the latest varactor multiplier techniques to obtain maximum reliability and efficiency and providing a minimum output power of 1/2 watt at 2295 Mc. The transponder receiver is designed to include automatic gain control circuitry. K.W.

N67-39315# Sperry Rand Research Center, Sudbury, Mass.
BACKSCATTER SIGNATURE STUDIES FOR HORIZONTAL AND SLANT RANGE VISIBILITY
Richard T. Brown, Jr. May 1967 213 p refs
(Contract FA-65-WA-1315)
(RD-67-24)

Analytical and experimental results of a study of a backscatter signature system for measurements indicative of horizontal and slant visual range are presented. The physics of the concept, including the relationships between characteristics of a time display of backscattered laser energy and the extinction coefficient of the visibility restricting scattering medium, also is discussed. Data obtained simultaneously from the backscatter signature system and conventional transmissometers were used to investigate the effectiveness of the measuring technique and the changes in the operating characteristics obtained by varying the system configuration. The backscatter signature measurements, converted to atmospheric transmittance, compare well with those of the transmissometer, considering certain incompatibilities between the measuring systems. The optimum system configuration and design parameters are discussed with respect to the design of a backscatter signature system. Author

N67-39334*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
MATHEMATICAL RELATIONSHIPS OF THE MFOD ANTENNA AXES
I. M. Salzberg May 1967 17 p
(NASA-TM-X-55956; X-553-67-213) CSCL 17I

The three different primary coordinate systems used for tracking equipment are the azimuth-elevation, X-Y, and hour angle declination systems. To complete a space fix, the third orthogonal coordinate is slant range when used. The advantages and disadvantages of each of these coordinate systems are tabulated. At many of the remote Manned Space Flight Network tracking sites, equipment using two different coordinate systems has been installed in relatively close proximity. To use pointing data in one coordinate system on equipment utilizing another coordinate system requires a transformation of the data from one coordinate system to the other. This report develops all the equations required to interrelate position data of the three coordinate systems. Author

N67-39350*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
INTRODUCTION TO BOSE–CHAUDHURI–HOCQUENGHEM CODES
S. A. Tretter Sep. 1967 39 p refs
(NASA-TM-X-55947; X-711-67-431) CFSTI: HC $3.00/MF $0.65 CSCL 09D

The basic mathematical concepts and definitions necessary for understanding and using the Bose–Chaudhuri–Hocquenghem (BCH) codes are introduced. These algebraic block codes are attractive because of the simplicity of the digital equipment necessary for coding and decoding. The simplicity in the case of binary codes results from the fact that multiplication of elements in $GF(2^m)$

can be performed instantaneously using logic gates while division is easily performed with shift registers. Some typical circuits used for $GF(p^m)$ arithmetic are discussed. BCH codes belong to the class of algebraic codes known as cyclic codes. Cyclic codes are defined and some of their properties are explained. BCH codes are then discussed in terms of their generator polynomials, distance structure, and use in error detection and correction. Shortened BCH codes are briefly described. R.N.A.

N67-39352*# Mississippi State Univ., State College. Dept. of Electrical Engineering.
A STUDY OF 2 GHz REGION ELECTROMAGNETIC PROPAGATION OVER SELECTED TERRAINS Progress Report, 1 Sep. 1965–1 Mar. 1966
James O. Hebert, Jr. 23 Mar. 1966 29 p ref
(Grant NGR-25-001-007)
(NASA-CR-71820) CFSTI: HC $3.00/MF $0.65 CSCL 09F

The paths to be used in the experimental reliability study were selected. These paths are part of the Texas Eastern Transmission Corporation 2 GHz microwave system. Instrumentation of all ten paths for signal level distribution analysis was completed. Approximately twenty percent of the total signal distribution data was taken. Seventy-five percent of this data was analyzed. Work is underway for obtaining simultaneous recordings of the receiver AGC signals for three propagation paths. Author

N67-39368*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
NASA AIRCRAFT/SPACECRAFT TELEMETRY RECEIVING SYSTEMS Final Report
D. Graham and D. Brown Sep. 1967 143 p
(NASA-TM-X-55980; X-822-67-482) CSCL 09F

The use of aircraft as data acquisition terminals for the Manned Space Flight Network was evaluated. An experimental system was installed in one of the MSFN instrumented Aircraft, NASA 432 and a series of test flights were made in conjunction with Gemini, Saturn/Apollo and other programs. The principal effort was directed toward reducing the limitations imposed on the airborne system by the multipath phenomenon. The characteristics of the reflection process were verified by measurements, and a number of techniques, designed to reduce the interfering effect of the reflected wave, were evaluated. Experimental results were applied to the design of the ARIA system. A description of the aircraft system capability is provided for potential users, and the results of the investigative program are summarized. Author

08 COMPUTERS

Includes computer operation and programming; and data processing. For basic research see: 19 Mathematics.

N67-38097# Lincoln Lab., Mass. Inst. of Tech., Lexington.
THREE FORTRAN PROGRAMS THAT PERFORM THE COOLEY-TUKEY FOURIER TRANSFORM
Norman M. Brenner 28 Jul. 1967 35 p refs
(Contract AF 19(628)-5167)
ESD-TR-67-462; TR-1967-2; AD-657019)

Three programs are described and listed, all written in USASI Basic Fortran, which perform the discrete Fourier transform upon a multidimensional array of floating point data. The data may be either real or complex, with a savings in running time for real over complex. The transform values are always complex and are returned in the array used to carry the original data. The running time is much shorter than that of any program performing a direct summation, even when sine and cosine values are precalculated and stored in a table. For example, on a CDC 3300 with floating point add time of six microseconds, a complex array of size 80 x 80 can be transformed in 19.2 seconds. Besides the main array, only a working storage array of size 160 need be supplied. Author (TAB)

N67-38110# RAND Corp., Santa Monica, Calif.
DATA AUTOMATION DEVELOPMENT AND SYSTEMS IMPLEMENTATION—SOME PROBLEMS AND CONCLUSIONS
A. E. Wessel Aug. 1967 31 p refs Presented at the Intern. Patent Officer's Assoc. Meeting, Stockholm, 18–23 Sep. 1967
(P-3648; AD-657005)

This report contains the authors views concerning the development and implementation of data automation or information processing systems over the past decade. In addition it considers an on-going experimental patent search system being implemented by the research and development people of the U. S. Patent Office in conjunction with The RAND Corporation. TAB

N67-38174# Massachusetts Inst. of Tech., Cambridge.
SYMBOLIC MATHEMATICAL LABORATORY
William A. Martin (Ph.D. Thesis) Jan. 1967 340 p refs
(Contract Nonr-4102(01); Proj. MAC)
(MAC-TR-36; AD-657283)

A large computer program has been developed to aid applied mathematicians in the solution of problems in non-numerical analysis which involve tedious manipulations of mathematical expressions. The mathematician uses typed commands and a light pen to direct the computer in the application of mathematical transformations; the intermediate results are displayed in standard text-book format so that the system user can decide the next step in the problem solution. Three problems selected from the literature have been solved to illustrate the use of the system. A detailed analysis of the problems of input, transformation, and display of mathematical expressions is also presented. Author (TAB)

N67-38176*# Georgia Univ., Athens. Computer Center.
DIRECTORY OF COMPUTER PROGRAMS AVAILABLE FROM COSMIC, VOLUME I
1 Jul. 1967 135 p Prepared jointly with NASA
(NASA-CR-89071) CSCL 09B

Descriptions and directories of numerous computer programs on various technical subject areas, fully operational with sufficient documentation to run, and available for a fee, are presented. Some of the areas which the programs cover are: 1) structural analysis, 2) random vibration, 3) flow distribution, 4) aerodynamic characteristics, 5) electric circuits and properties, 6) linear matrix calculations, 7) power spectra, 8) gas properties, 9) polynomial equations, 10) least squares analyses, 11) boundary equations, 12) heat transfer, and 13) voltage breakdown. Other subject areas are also covered. L.S.

N67-38188# Los Alamos Scientific Lab., N. Mex.
FORTRAN BKW: A CODE FOR COMPUTING THE DETONATION PROPERTIES OF EXPLOSIVES
Charles L. Mader 10 Jul. 1967 47 p refs
(Contract W-7405-ENG-36)
(LA-3704) CFSTI: HC $3.00/MF $0.65

A FORTRAN code for the CDC 6600 computer is described. The code computes the steady-state detonation properties of an explosive using the Becker–Kistiakowsky–Wilson equation of state. Author (NSA)

N67-38191# RAND Corp., Washington, D. C.
SOVIET CYBERNETICS: RECENT NEWS ITEMS NUMBER 7
Wade B. Holland, ed. Aug. 1967 73 p refs
(P-3600/7; TT-67-62623; AD-657004)

Contents: Brief items; Soviet cybernetics highlights, 1966; Another critical look at computer industry; Dnepr-1 on board research ship (photograph); Mechanization and automation hardware output, 1958-66; More from Gvishiani on industrial management; Organizational chart of sigma association; Glushkov on philosophical problems of cybernetics; Whom does cybernetics serve: 1953 Attack on Cybernetics; Future developments in computer design; Articles and photographs in the Soviet press, July 1967. TAB

N67-38195# Massachusetts Inst. of Tech., Cambridge.
AN ON-LINE SYSTEM FOR ALGEBRAIC MANIPULATION
Robert Ross Fenichel (Ph.D. Thesis—Harvard Univ., Jul. 1966) Dec. 1966 115 p refs
(Contract Nonr-4102(01); Proj. MAC)
(MAC-TR-35; AD-657282)

FAMOUS is an on-line system for the manipulation of linguistic forms. Although these forms can have quite arbitrary interpretations, the standard interpretation is that they are algebraic expressions. FAMOUS allows its algebraic expressions to include arbitrary functions which may or may not be defined. In this way, regular non-algebraic constructions may be concealed as arguments of ad hoc functions. Rules of local change are the heart of FAMOUS, and supplied by the user. Using these rules, FAMOUS looks at an algebraic manipulation as a series of local changes. The centrality of proximity in FAMOUS was orginally prompted by G-theory, which might be called the study of proximity. The presentation in Chapter II is complete, but it has rather a cookbook tone. Chapter III is a more reflective attempt to define the power and nature of the system. Algebraic simplification has been a benchmark of algebraic manipulators, and it is discussed in Chapter IV. A more novel application, that of limit problems, is discussed in Chapter V. Finally, Chapter VI consists of miscellaneous remarks about possible and impossible lines of further work. Author (TAB)

N67-38234*# Israel Program for Scientific Translations, Ltd., Jerusalem.
AN AUTOMATIC PROGRAMMED SCALER
L. V. Granitskii, A. F. Neermolov, Yu. K. Vorob'ev, and G. V. Kononova *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 300–303 (See N67-38201 23-29)

A brief description is given of the basic units of the scaler intended for research on radioactive materials, and a circuit diagram is included. The components of the counting and time channels are outlined. The designs and operations of code converter, programming unit, and recording device are indicated. The prespecified programs for the scaler operation are outlined. N.E.N.

N67-38263# Stanford Research Inst., Menlo Park, Calif.
RESEARCH ON INTELLIGENT QUESTION-ANSWERING SYSTEM
Claude Cordell Green and Bertram Raphael May 1967 52 p refs
(Contract AF 19(628)-5919)
(AFCRL-67-0370; SR-1; AD-656789)

This report describes progress toward an intelligent question-answering system--a system that can accept facts, retrieve items from memory, and perform logical deductions necessary to answer questions. Two versions of such a system have been implemented, and the authors expect these to be the first in an evolving series of question-answerers. The first system, QA1, is based upon relational information organized in a list-structured memory. The data consist of general facts about relations as well as specific facts about objects. QA1 has limited deductive ability. QA2 is based upon formal theorem-proving techniques. Facts are represented by statements in the predicate calculus. Although the memory organization is simpler than that of QA1, the sophisticated logical abilities of QA2 result in greater question-answering power. The report gives examples of the performance of QA1 and QA2 on typical problems that have been done by previous question-answerers, and describes plans for extending the capabilities of QA2. Author (TAB)

N67-38333*# Northeast Louisiana State Coll., Monroe.
DIGITAL FILTERS FOR NON-REAL-TIME DATA PROCESSING
James T. Taylo Washington, NASA, Oct. 1967 208 p refs
(Contract NAS8-11492)
(NASA-CR-880) CFSTI: HC $3.00/MF $0.65 CSCL 09B

Digital filtering techniques have become significant methods for data processing. This report presents the general theory through the definition of a digital filter and also presents a class of digital filters, called Martin–Graham filters, which are particularly well-suited to the operation of data smoothing. Included in this class are filters for non-real-time smoothing; smoothing and differentiation; smoothing and interpolation; smoothing, differentiation, and interpolation; and smoothing and integration. Application of these filters requires that the data be band-limited. In most cases, error bounds are given. Sample programs and sample results are also included. Author

N67-38356# Oak Ridge National Lab., Tenn.
A DIGITAL FILTERING TECHNIQUE FOR EFFICIENT FOURIER TRANSFORM CALCULATIONS
S. J. Ball 12 Jul. 1967 20 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1778) CFSTI: HC $3.00/MF $0.65

A method for calculating Fourier transforms is presented which capitalizes on the similarity between the Fourier transform integral and the convolution integral. The method is implemented by an efficient digital computer code, which uses a digital simulation of a sine–cosine filter. Although this method is mathematically equivalent to a direct numerical calculation of the Fourier transform, it takes about one-third the time required for the direct integration. The code has been used extensively for calculating frequency response functions from pulse response test data and from cross- and auto-correlation functions. Author (NSA)

N67-38364 European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
AN APACHE "SUBROUTINE" FOR GENERATING PADE'S CIRCUITS
C. Bona Aug. 1967 24 p refs
(EUR-3559.e)

With Apache it is possible to write programs corresponding to analog circuits of common use which can be considered as the subroutines or functions in digital programs. In fact, when a problem requires a circuit for which a subroutine has been written one can avoid to write the corresponding equations just by adding the deck constituting the subroutine to the Apache deck representing the problem. Two subroutines for generating any number of Pade's circuits for fixed and variable time delays are described. Author

N67-38419# Oak Ridge National Lab., Tenn.
STATPAK
Norma C. Hull Jul. 1967 176 p
(Contract W-7405-ENG-26)
(ORNL-TM-1863) CFSTI: HC $3.00/MF $0.65

Three classes of statistical computer programs which are available to use on the ORNL computers are described. The classes are: regression analysis, linear and nonlinear; analysis of variance, for one-way classification, for factorial experiments, and for three way classifications with multiple observations; and graphing programs. Some programs are modifications of the BIMD and BMD series written at the University of California at Los Angeles; some are original programs developed by the Statistics Section of the Mathematics Division; and others are modifications of programs prepared by personnel of other divisions of ORNL. Author (NSA)

N67-38501# Idealab, Inc., Franklin, Mass.
INVESTIGATION AND CONTINUED DEVELOPMENT OF THE IDEALAB FOURIER TRANSFORM ANALOG COMPUTER Final Report, 1 Nov. 1965–31 Oct. 1966
Alvan H. Bullard 1 Jun. 1967 33 p ref
(Contract AF 19(628)-5653)
(AFCRL-67-0395; AD-657360)

The report describes the modifications of the Idealab Fourier Transform analog computer and the results obtained from these modifications. Indicated in the report is the final figure of a resolution for an input of 2249 sin wave cycles within one frequency increment (14% of the (sin x)/x crossover). Also indicated in the report are the methods and circuitry used to obtain this accuracy and operator instructions for the new controls. Emphasis is placed on the electronic and engineering considerations of the monitor panel, white light actuator, velocity servo, precision clamp and oven control. A complete set of blue prints covering the modifications is provided at the end of the report. Author (TAB)

N67-38515# National Academy of Sciences—National Research Council, Washington, D. C.
SHAPING THE MIND: COMPUTERS IN EDUCATION
Ralph W. Gerard *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 207–228 refs (See N67-38508 23-34)

An overview of the technology of human behavior deals with value problems involved in tinkering with man's mind, the biological approaches to altering behavior and the accompanying brain changes, the impact of computer technology on the educational processes and the education establishment, and the social consequences of these technological developments. Indoctrination, control, and privacy are considered as value problems; and biological and behavior controls are considered in terms of the changes that might result. Applicability and costs of computer-aided learning are treated, along with the impact of this new technology on the changing educational process and social evolution. M.W.R.

N67-38562# Naval Weapons Center, China Lake, Calif.
RANDOM BINARY SEQUENCES
W. O. Alltop Aug. 1967 10 p
(NWC-TP-4394; AD-657307)

Two coding problems are considered. One is to obtain binary codes with desirable auto-correlation functions. The other is to obtain families of such codes with desirable cross-correlation functions. The results of a random computer search for the codes are described. An approximation to the expected number of trials in a search for families of codes is also presented. Author (TAB)

N67-38614 Joint Publications Research Service, Washington, D. C.
PROGRAMMING MICROLANGUAGE ON THE URAL-4 COMPUTER AND SORTING ON MAGNETIC TAPE
7 Jul. 1967 20 p refs Transl. into ENGLISH from Kibernetika (Kiev), no. 6, Nov.–Dec. 1966 p 47–49, 79–84
(JPRS-41733; TT-67-32385) CFSTI: $3.00

CONTENTS:
1. A PROGRAMMING MICROLANGUAGE FOR THE URAL-4 COMPUTER V. B. Borshchev, Ya. P. L. Vasilevskiy, and M. V. Khomyakov p 1–5 ref (See N67-38615 23-08)
2. AN ALGORITHM FOR SORTING ON MAGNETIC TAPES A. I. Nikitin and L. I. Sholmov p 6–15 refs (See N67-38616 23-08)

N67-38615 Joint Publications Research Service, Washington, D. C.
A PROGRAMMING MICROLANGUAGE FOR THE URAL-4 COMPUTER
V. B. Borshchev, Ya. P. L. Vasilevskiy, and M. V. Khomyakov *In its* Programming Microlanguage on the URAL-4 Computer and Sorting on Magnetic Tape 7 Jul. 1967 p 1–5 ref (See N67-38614 23-08)

The basic features of a computer program microlenguage, MYaU, to be used with the Ural-4 computer, are described. An exact description of MYaU, its syntax, and the rules for translating it into the command language of the Ural-machine is presented elsewhere. Some examples of names, commands, and lines of MYaU are given. Conditions for obtaining the lines are stated. The capacity of the translator programmed on the Ural-4 computer is 10,000 commands (octonary). The translator is located on a magnetic tape and uses a magnetic drum for storing. The rate of translation is 30 commands (decimal) per minute. L.S.

N67-38616 Joint Publications Research Service, Washington, D. C.
AN ALGORITHM FOR SORTING ON MAGNETIC TAPES
A. I. Nikitin and L. I. Sholmov *In its* Programming Microlanguage on the URAL-4 Computer and Sorting on Magnetic Tape 7 Jul. 1967 p 6–15 refs (See N67-38614 23-08)

An algorithm which makes it possible to sort groups with the aid of two or more magnetic tapes is presented. The algorithm compares the number of sorting runs made by a method described here, with the sorting runs made by one of the most widely used methods of combining. An example illustrating the entire algorithm for sorting, is given. L.S.

N67-38668# RAND Corp., Santa Monica, Calif.
COMPUTER AIDS FOR AEROSPACE DESIGN AND ENGINEERING: INNOVATION, ECONOMICS AND PUBLIC POLICY
Curtis P. McLaughlin Jul. 1967 59 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5264-PR; AD-657009)

A discussion of the applications of computer systems to the weapons systems development process, with emphasis on the role that the government might play in promoting, supporting, and implementing development of new computer-based systems for engineering support in the aerospace industry. Potential payoffs to the government lie in reduction of design costs, improvement of design and product performance, enhancement of engineering and creativity and productivity, and reduction of lead time for design, prototype production, and final production. A number of alternatives are open to the government in increasing the rate of development and diffusion of computer technology in industry. To determine the level and nature of such support, it is recommended that a study be made of the specific economic benefits that would result. Author (TAB)

N67-38815*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A PTOLEMAIC FRAMEWORK FOR COMPUTER PROGRAM COMPLEXES

Abrom Hisler Oct. 1967 7 p refs
(NASA-TM-X-55961; X-721-67-499) CFSTI: HC $3.00/MF $0.65
CSCL 09B

The application of the Ptolemaic system of epicycles to a master control logic program is described. A block diagram of an existing master control system is used to illustrate the concept. By transforming the block diagram to a circle, the master control in effect pivots program control to each of the modules in the order desired. The block diagram can be visualized as a big decision circle in which the radial arm pivots about. The decision circle concept can then be expanded to assume the static form of the Ptolemaic structure of deferent/epicycle. Using the static deferent/epicycle as a recurring building block, it is possible to develop as complex a Ptolemaic system as desired to represent a given computer program complex. Master control pivots about to any of the subroutine circles having centers on the circumference of the largest master control circle. In turn, a subroutine circle carries on its circumference the centers of circles representing lesser level routines. R.N.A.

N67-38874*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
AUTOMATIC DESIGN OF OPTICAL SYSTEMS BY MEANS OF AN IBM DIGITAL COMPUTER EMPLOYING THE IBJOB MONITOR
L. F. Schmidt and T. A. Casad 1 Oct. 1967 132 p
(Contract NAS7-100)
(NASA-CR-89232; JPL-TR-32-790) CSCL 09B

This report describes a digital computer program using geometrical optical techniques for the automatic design of optical systems. The digital program utilizes a least squares optimization method employing computing equipment embodied in the IBJOB monitor; the program is written primarily in MAP computer language. The report presents methods of entering optical data into the program, correlates the optical parameters with the program input requirements, and describes the output printout. Author

N67-38950 Joint Publications Research Service, Washington, D. C.
MATHEMATICAL PROBLEMS OF CYBERNETICS AND COMPUTER ENGINEERING
28 Sep. 1967 46 p refs Transl. into ENGLISH from the publ. "Trudy Vychislitel'nogo Tsentra Akademii Nauk Armyanskoy SSR i Yerevanskogo Gosudarstvennogo Universiteta, III, Matematicheskiye Voprosy Kibernetiki i Vychislitel'noy Tekhniki, Modelirovaniye Protsessov Upravleniya", Yerevan, Acad. of Sci. Armenian SSR Publ. House, 1965 p 1-95
(JPRS-42802; TT-67-33429) CFSTI: $3.00

An all purpose compiler for certain transformations of logical systems is described. The special features of the compiler are listed, and the theoretical bases are discussed. The logical diagram of an algorithm in the computer memory is investigated, and transformations and operators involved are covered. The class of diagrams programmed, and the procedures of getting the input information into the computer are outlined. Problems connected with the construction of the forming operator in cases where the initial value of the parameter is a variable are investigated, and examples are presented. N.E.N.

N67-39035 Japan Atomic Energy Research Inst., Ibaraki. Div. of Health Physics and Safety.
ORTHONORMAL EXPANSION CODE ACOF FOR ANALYSIS OF NEUTRON SPECTRA AND DOSE EQUIVALENT RATES
Hiroshi Ryufuku Apr. 1967 21 p refs In JAPANESE; ENGLISH summary
(JAERI-1140)

The code is for the IBM 7044. An orthonormal set of function is obtained by selecting base functions and a density function to be orthornormalized by the Schmidt method or by preparing conventional orthogonal functions (Fourier, Bessel functions, and Laguerre polynomials) in the subroutine. This code can be used for the analysis of spectra and dose equivalent rates not only of neutrons but also of photons, and can further be applied to such an analogous problem as calculation of the spatial distribution of radioactive substance. The time spent in calculation is about one minute, in the case where 10 detectors and 33 energy mesh points are treated. Author

N67-39043* Oak Ridge National Lab., Tenn. Neutron Physics Div.
FLEXI-KLUDGE—A MULTI-PARAMETER NUCLEAR SPECTRUM SUMMING SYSTEM FOR THE PDP-8
B. W. Rust and W. R. Burrus 16 Aug. 1967 69 p
(NASA Order R-104(1))
(NASA-CR-88974; ORNL-TM-1879) CSCL 09B

The programs described in this report were originally written to use a 256 word buffer beginning in core location 1000 but they were later changed so that they use only the first 40_8 locations in this buffer leaving the remaining 340_8 locations for more programs. Switches are also available for controlling the number of words per event and these can be set for any of the numbers 1, 2, 3, or 4. These programs are designed for 4 words per event. The 4 words are referred to in the programs and in this report as words T, B, C, and D though sometimes word T may also be referred to as word G or occasionally as word A. As the 4 words for each new event come into the buffer, an address counter is counted up by 4 so that the next event will occupy the next 4 words in the buffer. This address counter works in a circular fashion so that it starts again at the beginning of the buffer when the end of it is reached. To prevent the data buffer from filling up and new events being written over all events which have not yet been processed the data break contains an up-down counter which counts up the new words coming in and can be counted down by the program as old words are taken out of the buffer and processed. If the data rate becomes fast enough that the data buffer fills up faster than the program can empty it out, then each time the buffer is completely filled with unprocessed data the up-down counter overflows and this condition stops new data from coming in until some of the old data has been removed and the up-down counter counted down by the program. Author

N67-39299# Westinghouse Electric Corp., Baltimore, Md. Surface Div.
SELF-REPAIR TECHNIQUES INVESTIGATIONS Final Report, 1 Jun. 1966-31 May 1967
Frank B. Cole and Samuel E. Zimmerman Aug. 1967 108 p
(Contract DA-28-043-AMC-02343(E))
(MDE-2566; ECOM-02343-F; Rept.-4; AD-657247)

The report describes a set of techniques which can be used to design and construct self-repairing digital systems with spare parts switching. Both the problem of fault detection and location and the problem of spare switching are discussed. Residue coding for arithmetic unit fault detection and location is discussed and rejected. Then, duplication techniques for both fault location and repair are discussed. A design plan is given for a demonstration model to demonstrate self-repair techniques. The design plan includes logic equations, timing diagrams, and a detailed operational description. Finally, recommendations are made for future efforts. Author (TAB)

N67-39381 Compagnie Generale de Telegraphie Sans Fil, Puteaux (France)
BATCH FABRICATED INTEGRATED ALL-MAGNETIC LOGIC
M. Carbonel and V. Chaptal [1966] 13 p refs

All-magnetic logic is known for its very high reliability but this logic shows serious drawbacks: wiring cost, high power dissipation, etc. The use of very thin laminated magnetic sheets and an integrated fabrication process solves all these problems. Very low cost, power, size and weight, and an extreme reliability can be obtained by this technique. An experimental integrated two-bits shift register has been fabricated. Author

09 ELECTRONIC EQUIPMENT

Includes electronic test equipment and maintainability; component parts, e.g., electron tubes, tunnel diodes, transistors; integrated circuitry; microminiaturization. For basic research see: 10 Electronics. For related information see also: 07 Communications and 21 Navigation.

N67-38129# New York Univ., N. Y. Research Div.
ELECTRONIC TEST EQUIPMENT NOMENCLATURE ASSIGNMENTS. VOLUME I: SYSTEMS
Jun. 1967 407 p refs
(Contract NObsr-89288)
(AD-654106) CFSTI: HC $3.00/MF $0.65

Contents: Nomenclature Designation System; Agency Abbreviations; Abbreviations of Technical Terms; Alphanumeric Listing. TAB

N67-38156# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
JUNCTION FIELD-EFFECT TRANSISTOR CHARACTERISTICS RELEVANT TO ANALOG SWITCH CIRCUITS
Edgar H. Fischer (M.S. Thesis) Apr. 1967 112 p refs
(Contract NOw-62-0604-c)
(TG-908; AD-656889)

The junction Field-Effect Transistor (FET) is evaluated for use in analog switch circuits. FET characteristics, such as channel resistance, drain cutoff current, pinch-off voltage and device capacitance, are analyzed for sensitivity to changes in temperature and voltage. Equivalent circuits are provided for an FET used as an analog switch. Separate equivalent circuits are used for transient analysis and steady-state analysis. A series analog switch is analyzed for turn-off transients that occur for various rise-time gate control signals. An effective voltage Ve is introduced to facilitate a two-part transient analysis for an initial and final turn-off transient. Turn-on transients are analyzed qualitatively. A steady-state analysis shows the effect of temperature on the error voltage at the analog switch output. Author (TAB)

N67-38159# General Electric Co., Schenectady, N. Y. Research and Development Center.
NEW SOLID-STATE DEVICE CONCEPTS
Manuel Aven, Walter Garwacki, Robert N. Hall, and John R. Richardson Jun. 1967 76 p refs
(Contract AF 19(628)-4976)
(S-67-1105; AFCRL-67-0427; SR-8; AD-657023)

Electrical transport studies in p-type ZnTe have confirmed that in the temperature range of about 80 to 500K the hole mobility is principally limited by LO phonon scattering. An effective mass ratio of 0.6 gives the best fit to the experimental data. The highest mobility, 6500 cm squared/v sec at 35K, was observed in a crystal with an active defect center concentration of 2 x 10 to the 15th power/cc. The ionization energy of the first charge state of a native acceptor, believed to be a Zn vacancy, was found to be = or > 0.057 plus or minus 0.002 ev. Low-resistance electrical contacts to p-type ZnTe and ZnSexTe1-x can be made by diffusing Li from a Li salt into the area of the crystal to be contacted and forming an electroless Au deposit on top of the Li-diffused area. The Li-Au contacts stay nearly ohmic down to 35K and have been used on crystals having carrier concentrations below 10 to the 9th power/cc. Detailed studies of the current voltage relations for thin-film diodes of gallium arsenide have shown that the negative resistance and bistable resistance at zero bias are intimately related to the properties of the tellurium counter-electrode. Optical and electrical measurements on the films of evaporated tellurium have shown these films to be p-type semiconductors with an energy gap of 0.7 to 0.8 volt. Diodes are now being fabricated in a geometry compatible with integrated circuit techniques. TAB

N67-38237# Stanford Research Inst., Menlo Park, Calif.
APPLIED RESEARCH IN THIN-FILM FIELD-EMISSION TUBES Quarterly Report, 1 Jan.–31 Mar. 1967
Clifford Hartelius, Jr. and Wilbur W. Hansen Jul. 1968 23 p ref
(Contract DA-28-043-AMC-01766(E))
(ECOM-01766-6; Rept.-31; QR-6; AD-657234)

Recent progress in the development of micron-size field emission diodes is reported. There has been a continuing difficulty in forming asperities on the molybdenum areas at the bases of micron-diameter cavities despite good results with bare molybdenum films. During this quarter, investigations of source-to-substrate configurations confirmed that asperity density is dependent on the angular displacement of the source and substrate axes used during the deposition of molybdenum cathode films. Also, it was found possible to grow asperities on molybdenum films deposited at normal incidence to the substrate but originating from source areas in the range from about 20 degrees to 50 degrees relative to the source axis. The influence of the vacuum environment, substrate temperature during molybdenum deposition, and aluminum thickness were then investigated for a fixed configuration (45 degrees source angle, normal incidence on substrate). The results indicate the following: asperity growth is optimum in residual gas pressures of the order of 0.000001 torr; the aluminum thickness should be about 200A or less; and the growth process is insensitive, over wide limits, to the substrate temperature used during molybdenum deposition. Moreover, it was found possible to grow asperities on a molybdenum surface over which aluminum oxide had previously been deposited and etched away (i.e., similar to the molybdenum areas at the bottoms of cavities) without the necessity for first depositing a fresh layer of molybdenum. Specimens with micron-diameter diode cavities have been subjected to the asperity formation process and are awaiting electrical tests for field emission activity. Author (TAB)

N67-38238# Rantec Corp., Calabasas, Calif.
MICROWAVE FILTERS UTILIZING DIELECTRIC RESONATORS Final Report, 15 Dec. 1966–15 Mar. 1967
William H. Harrison Jul. 1967 42 p refs
(Contract DA-28-043-AMC-02088(E))
(ECOM-02088-4; Rept.-66223; AD-657236)

Temperature compensation methods employed throughout the study program are briefly reviewed. Satisfactory temperature compensation has not been achieved. Several coupling structures were successfully designed permitting low loss coupling to the input and output resonators. A satisfactory tuning method has also been devised. The results of this program show that a band-pass filter employing dielectric resonators is practical to build, is compact, and approaches the performance of an equivalent waveguide filter. The design presented employs five resonators mounted in a

cylindrical tube which is 1.4 inch diameter by 4.3 inches long and weighs 4.6 ounces. An equivalent waveguide filter would be approximately 2.3 x 4.5 x 16 inches long and weigh approximately 64 ounces (WR-430). Author (TAB)

N67-38401# Aerospace Research Labs., Wright-Patterson AFB, Ohio.

PHOTOCATHODE-FILTER COMBINATION RESPONSE CURVES AND TABLES Final Report

Gary L. Duke Mar. 1967 169 p refs

(ARL-67-0067; AD-657026)

With the increasing use of photocathodes in all fields of basic and applied research there has arisen the need for the ability to make a quick selection of the correct photocathode for a particular situation. In a vast majority of the cases, however, it is not the photocathode alone which must be considered but a combination of photocathode and filter to be used in connection with a certain illuminating source so that a desired spectral sensitivity is achieved. These curves and tables are intended to make possible a quick selection of the proper combination. Data used in these calculations was taken from standard tables (Kodak Wratten Filters for Scientific and Technical Use and ITT Typical Absolute Spectral Response Characteristics of Photoemissive Devices), so that, although the spectral response and/or transmission of a particular combination may be slightly different because of production variations, aging, etc., these results are sufficiently accurate for most practical work. Author (TAB)

N67-38461# Rome Air Development Center, Griffiss AFB, N. Y.

PHYSICS OF FAILURE IN ELECTRONICS, VOLUME 5

Theodore S. Shilliday (Battelle Mem. Inst.) and Joseph Vaccaro, ed. Jun. 1967 580 p refs Conf. held at Columbus, Ohio, 15–17 Nov. 1966

(AD-655397)

Conference papers are presented dealing with material processes and phenomena influencing the degradation and failure of solid state electronic devices and related structures. For individual titles see N67-38462–N67-38489. M.W.R.

N67-38463# General Electric Co., Syracuse, N. Y. Electronics Lab.

PROGRESSIVE FAILURE MECHANISMS OF A COMMERCIAL SILICON DIODE

J. F. Schenck *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 18–35 refs (See N67-38461 23-09)

(Contract AF 30(602)-3624)

Two forms of progressive degradation of a commercial silicon signal diode are noted as a function of various stress and measurement variables. One mode results from reverse bias at high temperature, and the second is caused by prolonged stressing with high forward current. For both modes the rate of degradation can be greatly increased by raising the ambient temperature. The reverse current characteristic is the principal degrading parameter for both modes. Models are presented to relate the stress-induced increases in I_R to physical and chemical changes taking place in the diode. The reverse bias degradation mode is explained by a model based on the drift of impurity ions in the silicon oxide and the resultant inversion of the epitaxial n layer. The actual source of the reverse current is space charge generation in the stress-induced inversion layer. Author

N67-38464# Sperry Rand Research Center, Sudbury, Mass.

OPTICAL SCANNING TECHNIQUES FOR SEMICONDUCTOR DEVICE SCREENING AND IDENTIFICATION OF SURFACE AND JUNCTION PHENOMENA

C. N. Potter and D. E. Sawyer *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 37–50 (See N67-38461 23-09)

The electrical response of semiconductor devices to light can be used to study various device phenomena and to identify the causes of anomalous device behavior. To implement such a study, a flying spot scanner has been constructed. This instrument deflects a light beam into a raster pattern and focuses it on the device under test. The light source is a helium-neon laser. Sinusoidal sweeps are used for simplicity. The electrical output from the device is amplified and intensity modulates the electron beam of a cathode-ray tube. By synchronizing the CRT beam deflection with the light spot on the sample, an image of the device electrical output is traced on the CRT. The resolution is about 5 μ (0.0002"), referred to the surface under study. Interpretation of the image yields the desired device information. The system is constructed from standard experimental laboratory equipment. Author

N67-38465# Rome Air Development Center, Griffiss AFB, N. Y.

PHOTORESPONSE MAPPING OF SEMICONDUCTORS

J. R. Haberer *In its* Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 51–82 (See N67-38461 23-09)

The effect of light on various semiconductor characteristics are noted. An improved method for obtaining photoresponse measurements on semiconductor junctions has been developed whereby the entire junction topography of a semiconductor device may be displayed. Some of the results obtained using this technique and its usefulness as a possible screening tool are presented. The method used to obtain topological photoresponse displays is a modification of flying spot scanner techniques. A raster of variable fields per second as well as lines per field is generated and projected on the sample through suitable optical reductions. The photo-voltage generated by the sample is amplified, processed and then used to intensity modulate a display raster scanning in synchronism with the original raster. This technique uses common laboratory equipment. Author

N67-38467# Texas Instruments, Inc., Dallas.

RELIABILITY SCREENING PROCEDURES FOR INTEGRATED CIRCUITS

W. Gill and W. Workman *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 101–142 refs (See N67-38461 23-09)

Reliability screening techniques for integrated circuits are discussed which can be used in conjunction with a standard process that normally produces material suitable for less stringent reliability applications. Devices can be selected by subjecting this material to additional conditioning and selective procedures at three levels: precapsulation lot acceptance for metal adherence and bond integrity; 100% die and package inspections; and post capsulation conditioning and screening. The information obtained from accelerated stress tests, failure analysis, physics of failure studies, and data analysis is used to demonstrate the effectiveness of new screening techniques. Author

N67-38468# International Business Machines Corp., Hopewell Junction, N. Y. East Fishkill Facility.

LOAD-LIFE TESTS OF Cr–SiO CERMET THIN-FILM RESISTORS

P. M. Schaible, J. C. Overmeyer, and R. Glang *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 143–157 refs (See N67-38461 23-09)

Cr–SiO cermet thin films, used to fabricate microminiature resistors which are compatible in size with monolithic circuits, are discussed. The stability of these resistors under thermal and power stresses of up to 200°C ambient temperature and 80 mw/mil^2 power density is investigated. At 200°C and with 20 mw/mil^2 dissipated on 1 mil x 5 mil resistors of 150 ohms, the resistance changes observed on stabilized Cr–SiO films were less than 0.2% after 1000 hours; however, the reliability of these resistors was found to depend on the contact metal. Degradation of the Cr–SiO/metal

contact was observed with Al terminals. The incidence and magnitude of this degradation are a function of storage temperature, dc load, and polarity, and can be related to the formation of a high-resistance region at the anodic Al/Cr–SiO contact. This degradation does not occur when Cu or Au films are used to terminate the resistors, and these devices can dissipate 20 mw/mil^2 at 200°C without resistance changes. Author

N67-38470# Radio Corp. of America, Somerville, N. J.
STABILITY OF THIN-FILM TRANSISTORS
J. J. Fabula, R. L. Schelhorn, and M. L. Topfer *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 183–197 refs (See N67-38461 23-09)

Vacuum evaporated thin-film transistors fabricated with cadmium sulfide (n-type), cadmium selenide (n-type), and tellurium (p-type) for the semiconductor material are discussed. These devices have been made using both the staggered and coplanar geometries. Life test data has been taken on devices fabricated using these semiconductor materials. Correlation is made between the observed instabilities in each of these materials. At least two distinct instabilities have been observed. The first is a "short term" instability which takes place in some number of minutes depending on the device under examination. The "long term" instability takes place in some number of hours, again depending on the device under examination. Author

N67-38473# Hitachi, Ltd., Tokyo (Japan). Central Research Lab.
FAILURE MECHANISMS IN PASSIVATED P^+–N JUNCTIONS UNDER TEMPERATURE AND BIAS STRESS
Takashi Tokuyama *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 244–264 refs (See N67-38461 23-09)

The mechanisms for anomalous increase of reverse current by reverse bias and temperature stress treatment on silicon p^+–n planar junctions are analysed in detail. The effect of surface characteristics upon junction I-V curve is first surveyed generally by preparing the samples that have MOS type gate electrode in three types of configurations. Gate voltage to junction current curves are compared before and after the stress treatment and concluded that after the stress treatment, n-type inversion layers are formed on the very confined portions of the p-type diffused layer. It is also indicated that units having high resistivity n-type substrate are easily deteriorated. It is concluded that n-type inversion layers are formed only on the p-type surface where the acceptor densities decrease by the lateral diffusion under the oxide mask. Author

N67-38476# Hughes Aircraft Co., Fullerton, Calif.
SURFACE EFFECTS OF RADIATION ON MOS TRANSISTORS
B. M. Kuehne *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 311–327 refs (See N67-38461 23-09)
(Contract N228(62479)66466)

Since the metal–oxide–silicon field effect transistor (MOSFET) is quite sensitive to radiation-induced surface effects, experimental evidence toward identification of mechanisms responsible for device degradation is discussed. In particular, the time dependence of effects following both pulsed and steady-state irradiation was studied, since information is thereby provided on the type and concentration of radiation-dependent charge trapping states which affect device conductivity. Both intermediate and semipermanent conductivity changes following exposure to ionizing radiation were studied for three types of MOSFET's, including n-channel enhancement, p-channel enhancement, and thin-film n-channel depletion units. Author

N67-38477# Radio Corp. of America, Princeton, N. J.
DEGRADATION OF MIS DEVICES UNDER ELECTRON BOMBARDMENT
K. H. Zaininger *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 328–348 refs (See N67-38461 23-09)

The behavior and physics of failure of MIS devices under irradiation with energetic electrons was investigated. It was found that the bombardment usually results in the introduction of positive charge in the insulator. This effect is explained by a physical model which involves interaction of secondary electrons with the insulator lattice to generate electron-hole pairs and predominant trapping of holes in the insulator. The dependence of the radiation sensitivity on pre-bombardment surface state density, device parameters, and fabrication procedure, as well as the annealing behavior was studied. Author

N67-38478# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
PROTON IRRADIATION EFFECTS IN MOS AND JUNCTION FIELD-EFFECT TRANSISTORS AND INTEGRATED CIRCUITS
Floyd R. Bryant, Carl L. Fales, Jr., and Roger A. Breckenridge *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 349–372 refs (See N67-38461 23-09)

The important electrical parameters of field-effect transistors and integrated circuits were measured before, during, and after irradiation at the 22-MeV cyclotron. The results obtained from the MOS field-effect study show that their degradation processes include that of charge storage in the silicon dioxide insulating layer and radiation-induced changes in surface states. MOS transistors have been found to degrade at orders of magnitude less integrated proton flux than many bipolar and junction field-effect transistors. The junction field-effect transistor displays a large initial spread in device irradiation response, but it appears to possess a high degree of resistance to proton irradiation. The monolithic integrated circuits under proton irradiation displayed a large reduction of minority carrier lifetime in the base region of the circuit transistors. Author

N67-38479# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missiles and Space Systems Div.
TEMPORARY NEUTRON DAMAGE IN TRANSISTORS
B. Barnett, L. M. Langsam, C. B. Schoch, and D. A. Schow *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 373–390 refs (See N67-38461 23-09)

The amount and duration of temporary neutron damage were measured in a wide variety of types of transistors. They all showed a decrease in the large-signal common-emitter current gain lasting about one second. Half of the damage recovered in a time of 0.0002 to 0.05 sec, for different types, and the ratio of the peak damage (just after the burst) to the permanent damage varied from 1.5 to 3. The amount and duration of the effect were much smaller in samples operated at relatively high junction temperatures. A model is proposed to explain the effect on the basis of the kinetics of the trapping and recombination processes occurring, as in a pnp transistor. Author

N67-38480# Fairchild Semiconductor Corp., Mountain View, Calif.
RADIATION TESTING OF LINEAR MICROCIRCUITS
J. D. Lieux *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 391–422 refs (See N67-38461 23-09)

The overall and individual component effects of fast neutron radiation on linear microcircuits are determined. Circuits tested were two operational amplifiers and two gold-doped comparators. One operational amplifier and the gold-doped comparators withstood up to 10^{14} nvt. The other operational amplifier withstood at least 3×10^{13} nvt. At these levels, gain was down about 50% on the comparators and input bias current was doubled. On the operational amplifiers, the input current showed a more severe degradation than the gain because more feedback was used. It is shown that both base transport factor and emitter efficiency degrade with radiation, and it has been determined that diffused resistors show

little change up to 10^{15} nvt. Since circuit design utilizes resistor ratios instead of absolute values, the effect is further reduced. Avalanche breakdown voltages increased due to higher resistivities as expected. Author

N67-38481# ITT Federal Labs., Palo Alto, Calif. Semiconductor Research Lab.

SECOND BREAKDOWN IN SILICON POWER TRANSISTORS AT HIGH COLLECTOR VOLTAGE

R. M. Scarlett and G. F. Hardy *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 424–443 refs (See N67-38461 23-09)

(Contract AF 30(602)-3975)

Noticeable differences in pulsed second breakdown performance which appear in high-frequency power transistors operated in the vicinity of BV_{CEO} are discussed. Devices with thin, lightly doped epitaxial collector regions show second breakdown at much lower currents than many devices having the same base and emitter structure but thick epitaxial collector regions. However, some of the latter devices also have low second breakdown currents. The early second breakdown can be predicted in terms of the negative resistance seen at the collector terminal with the base open. This negative resistance leads to internal instability and current crowding. At high voltages, the collector negative resistance is electrical in nature and does not depend on heating effects with consequent time lags so that the instability it introduces builds up very rapidly. It is caused by local reverse base current producing increased forward bias on the emitter junction as it flows through the sheet resistance of the base layer. Author

N67-38483 Texas Instruments, Inc., Dallas.

STUDIES OF THE UNIFORMITY OF AVALANCHE BREAKDOWN BY MEANS OF LOW FREQUENCY NOISE MEASUREMENTS

Roland H. Haitz *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 447–461 refs (See N67-38461 23-09)

The correlation between low frequency noise and the uniformity of the current distribution in avalanche diodes is investigated. It is found that small diodes with a uniform current distribution obey the theoretically predicted relation $u^2/\Delta f = a^2 V_b{}^2/I$ with $a^2 = 4.8 \cdot 10^{-20}$ A/Hz. Larger diodes exhibit excess noise which is above the theoretically predicted minimum, and which is traced to nonuniformities of the breakdown voltage across the avalanche junction. To characterize the uniformity of breakdown four quantities are defined which can be determined readily from noise and impedance vs current characteristics: (1) the number of noise peaks N; (2) the maximum noise figure $F_{\Delta D}$; (3) the relative breakdown voltage spread $\Delta V_b/V_b$; and (4) the impedance ratio r. The correlation between these quantities and the uniformity of avalanche breakdown is demonstrated on alloyed, planar, and guard ring diodes. Author

N67-38484# Northern Electric Co., Ltd., Ottawa (Ontario).

THE SIGNIFICANCE OF DISLOCATION DENSITY AND IMPURITY INHOMOGENEITIES TO THE BREAKDOWN CHARACTERISTICS OF PRODUCTION RUN PLANAR DIODES

D. R. Colton, P. Dakin, R. Falconer, and A. Slavin *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 462–475 refs (See N67-38461 23-09)

The effect of impurity striations and bulk dislocation density on the avalanche breakdown characteristics of production run planar diodes is studied. The diodes were prepared from both Czochralski and floating-zone grown silicon possessing large differences in impurity striation magnitude. Results of the detailed V-I measurements provided numerical data on leakage current, breakdown sharpness, and breakdown voltage. Statistical analysis then determined the significance of the bulk material properties with respect to the breakdown characteristics of the diodes. The results showed that impurity striations produce very large variations in leakage current in addition to variations in breakdown voltage. There was also some indication that a large bulk dislocation density, such as occurs in floating-zone silicon, results in premature breakdown of a small percentage of the diodes. Author

N67-38485# Bell Telephone Labs., Inc., Reading, Pa.

PREVENTION OF STRESS-CORROSION FAILURE IN IRON–NICKEL–COBALT ALLOY SEMICONDUCTOR DEVICE LEADS

M. J. Elkind and H. E. Hughes *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 477–495 refs (See N67-38461 23-09)

The susceptibility to stress corrosion cracking of the iron–nickel–cobalt alloy, commonly used for semiconductor device leads, is discussed. The work reported confirms that stress corrosion cracking of this alloy can occur very rapidly in the presence of a combination of condensed atmospheric moisture and stress. Detection of this phenomenon by accelerated tests is the basis for evaluating and introducing corrective measures to surmount this failure mechanism. Factors intensifying the alloy's susceptibility to stress corrosion when used as semiconductor encapsulation leads have been identified. Author

N67-38487# Westinghouse Electric Corp., Baltimore, Md. Aerospace Div.

A PLAGUE-FREE ALUMINUM–GOLD SYSTEM ON SILICON INTEGRATED CIRCUITS

M. A. Schuster and W. J. Lytle *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 506–518 (See N67-38461 23-09)

(Contract NAS8-5112)

A stable and reliable aluminum–gold system for interconnections, contact pads, and bonded lead wires for silicon integrated circuits is discussed. The system is completely consistent with the fabrication technology, packaging, storage, and operational requirements of standard integrated circuits. It is based on an isolation of the aluminum interconnection metal from the gold contact metal by the bulk substrate material. The interconnections are vapor deposited aluminum, contact pads are gold vapor deposited on a chromium wetting agent, and the bonded lead wires are gold. The interconnections are separated from the contact pads by a barrier domain of bulk silicon substrate material which has been degenerately dope. The system is not subject to degradation due to the intermetallic formation which is common in conventional aluminum–gold systems. Author

N67-38488# General Telephone and Electronics Labs., Inc., Bayside, N. Y.

CORRELATION OF ELECTRICAL, MICROSTRUCTURAL, AND CHEMICAL PROPERTIES OF HEAT-TREATED PLATINUM–SILICON CONTACT DEVICES

R. Silverman and N. Cerniglia (Sylvania Elec. Prod.) *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 519–533 refs (See N67-38461 23-09)

It is shown that planar transistors with good electrical properties can be prepared with platinum contacts heat treated from 550° to 700°C. Anomalous results were traced by microstructural, X-ray diffraction, and electron beam microprobe analyses to incomplete silicon dioxide removal or silicon reoxidation in the contact areas prior to platinum metallization. Author

N67-38489# Hamilton Standard Div., United Aircraft Corp., Broad Brook, Conn.

MICROBONDS FOR HYBRID MICROCIRCUITS

A. R. Riben, S. L. Sherman, W. V. Land, and R. Geisler *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 534–556 refs (See N67-38461 23-09)
(Contract DA-36-039-AMC-03742(E))

The results are presented of an extensive micro bonding program designed to establish the reliability of techniques for providing interconnections within hybrid microcircuits. The program included in investigation of bonding equipment parameters, film thicknesses, materials, and evaluation techniques. One phase of this work consisted of the evaluation of fine gold and aluminum wire microbonds to deposited gold–chromium or aluminum films on various substrates, including Vycor, as-fired and glazed alumina, sapphire, oxidized silicon, and beryllia. Both split-tip resistance welding and ultrasonic bonding techniques were employed for the fabrication of these bonds. Author

N67-38535*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SOME VARIATIONS OF TUNNEL DIODE PULSE GENERATOR CIRCUITS
Norman M. Garrahan Sep. 1967 22 p refs
(NASA-TM-X-55949; X-711-67-437) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A few of the new tunnel diode pulse generation circuits to be used on an X-ray investigation rocket experiment are described. Circuit component values are given with a brief explanation of the choice of input versus output pulse polarities. Author

N67-38668*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
SIMPLIFIED PROCEDURE FOR OBSERVATION OF BANDPASS OF S-BAND KLYSTRON POWER AMPLIFIER
T. E. McGunigal and J. P. D'Ippolito Aug. 1967 14 p
(NASA-TM-X-55948; X-523-67-432) CFSTI: HC $3.00/MF $0.65 CSCL 09A

In order to inspect the bandpass of the S-band klystron power amplifier at Apollo tracking stations with present techniques, it is necessary to carry an oscilloscope, a sweep generator, a TWT amplifier, a frequency meter, and auxiliary equipment to the site of the klystron. This paper discusses an alternative technique which simply utilizes the frequency synthesizer, already built into the exciter circuit, and a simple transistor sweep circuit. Included in this report are the schematic diagram of the sweep circuit, a detailed schematic diagram of how this technique can permanently be built into the exciter circuit, the result of experimentation already performed at the Goddard Apollo Station, and the estimated cost of the project. Author

N67-38720# New York Univ., N. Y. Research Div.
ELECTRONIC TEST EQUIPMENT NOMENCLATURE ASSIGNMENTS. VOLUME II: COMPONENTS
Jun. 1967 175 p refs
(Contract NObsr-89288)
(SETE-210/74, Vol. II; AD-654107)

A dictionary-type listing of military electronic test equipment components is presented in alphanumerical order by type designation; and each listing contains nomenclature, a brief functional description, manufacturer and model or part number, original agency, applicable military specification, and type designation of equipment used with or part of the item described. Type designations are according to MIL-STD-196B, dated December 22, 1965. This volume specifically deals with the electronic components, which are described as being part of or used with a system. Volume I of this document, SETE 210/74, deals with systems and Volume III contains cross references for the first two volumes. M.W.R.

N67-38774# Princeton, Univ., N. J. Plasma Physics Lab.
EVALUATION OF ARC DAMAGE TO POWER TRIODE GRID WIRES
G. Bronner, J. G. Murray, and J. P. Sorrentino *In its* Plasma Phys. Lab. May 1967 p 412–416 (See N67-38725 23-25)

Experiments to damage aluminum foil and a simulated grid structure were performed in air and in a vacuum in order to ascertain the minimum energy required to affect the grid structure of a power triode. Arcing was produced by discharging a charged capacitor through a load resistance; the diameter of the produced hole was a reliable measure of the dissipated energy. Results found that more than 3,000 J was required to inflict damage to grid wires in a vacuum. Holes associated with arc foil tests in a vacuum were not comparable with those produced in air and thus were not a guage for damage to the vacuum tube. G.G.

N67-38775# Princeton, Univ., N. J. Plasma Physics Lab.
DIGITAL COMPUTER REPRESENTATION FOR THE PARALLEL OPERATION OF LARGE DC GENERATORS IN A MULTIPLE-LOOP FEEDBACK CONTROL SYSTEM
H. M. Chandler, Jr. *In its* Plasma Phys. Lab. May 1967 p 417–421 (See N67-38725 23-25)
(Grant NSF GP-579)

A digital computer program was used to represent the negative feedback, closed-loop control system with magnetic amplifiers, dc exciters and other elements for parallel operation of devices in a peak-pulse power dc generator. The generator consisted of sets of four wound-rotor induction motors, each of which was required to be pulsed at 440% of rated current for an equivalent two-second flat top with 39 seconds recovery time between pulses. A basically Runge–Kutta subroutine integration was used to represent each nonzero time constant component of the system and nonlinear characteristics of system component responses were included by power series plus numerical limits to represent saturation levels. A mathematical model was computed for this complex control system that shows the response of each stage for a given set of load, damping, and gain parameters with the exception of the effect of armature reaction in each generator. G.G.

N67-38791* National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
FORMAC PROGRAM TO ASSIST IN THE ANALYSIS OF LINEAR CONTROL SYSTEMS USING STATE VARIABLE FEEDBACK DESIGN TECHNIQUE
Charles R. Slivinsky, Lois T. Dellner, and Dale J. Arpasi Washington, NASA, Oct. 1967 48 p refs
(NASA-TM-X-1443) CSCL 09C

A recently developed technique for control system design utilizes the feedback of all the state variables of the system. A program written in Formac to facilitate this design procedure is discussed. The program must be supplied the open-loop transfer function, properly segmented into as many parts as the order of the system. Algebraic expressions for the unknown state variable feedback coefficients (the gains through which the state variables are fed back) are then calculated. Under certain conditions that result in a set of n algebraic equations linear in the unknown feedback gains, the program accepts additional input (the transfer function describing the desired system response) and calculates the values of the feedback gains which yield this response. A root locus diagram is plotted to display system sensitivity to variations of the gain in the left-most block of the open-loop transfer function. Several examples of the use of the program are included and a complete program listing is given in an appendix. Author

N67-38813*# General Electric Co., Cincinnati, Ohio. Space Power and Propulsion Section.
DEVELOPMENT OF ELECTRICAL SWITCHGEAR FOR SPACE NUCLEAR ELECTRICAL SYSTEMS Quarterly Progress Report, 4 Dec. 1964–4 Mar. 1965

R. N. Edwards, ed. 4 Mar. 1965 57 p refs
(Contract NAS3-6467)
(NASA-CR-54401; QPR-1) CFSTI: HC $3.00/MF $0.65 CSCL 09A

Efforts during this period were devoted to material selection for the vacuum interrupter enclosure and contacts, interrupter and actuator design concepts, and facilities for making heat run and endurance tests. The candidate materials selected for testing were Rodar (a nickel–cobalt–iron alloy), thoria dispersed nickel, titanium, and arc cast molybdenum. Detailed checking of the switch contact resistance used for the interruption tests indicated high resistance and high temperature. A review of the contact problem pointed to high resistance, high losses, and a high temperature rise when the circuit breaker is carrying 600A. Design effort concentrated on the actuators after deciding to produce a single pole design for both ac and dc applications. Vacuum interruptor studies were initiated to determine heat transfer requirements. The design of a suitable vacuum test chamber oven using quartz lamps was developed. R.N.A.

N67-38868# New York Univ., N. Y. Research Div.
ELECTRONIC TEST EQUIPMENT NOMENCLATURE ASSIGNMENTS. VOLUME III: CROSS-REFERENCE
Jun. 1967 156 p Supersedes SETE-210/74
(Contract NOber-89288; Proj. SETE)
(SETE-210/74; Vol. III; AD-654108)

Part I contains a cross-reference of the data contained in Volume I—"Systems" and Volume II—"Components"; it is arranged company, manufacturer, or supplier in alphabetical order. For large companies with plants in many cities an attempt was made to give particular locations where the item was produced. The company name is followed by part or model numbers with their associated nomenclatures, designating test equipment (systems or components), made by this particular company; Part II contains part lists "Systems", not all of which are found in Volume I, followed by those components of the system which have a test function. If no item name appears with the system heading, it may be assumed that the prime system is a system in which the test function is secondary. The components are listed in alphanumeric order with their respective titles. Author (TAB)

N67-38878# Ceskoslovenska Akademie Ved, Rez.
DESCRIPTION OF CONTROL AND STABLIZATION OF ALTERNATING CIRCUIT OF ELECTRON BEAM SOURCE [OBVOD PRO REGULACI A STABILIZACI PROUDU ZHAVICIHO VLAKNA ELEKTRONOVEHO ZDROJE]
F. Srepl Feb. 1967 9 p In CZECHOSLOVAKIAN
(UJV-1716)

A simple circuit for stabilizing and control of an alternating circuit for heating the filament of an electron gun is described. The circuit consists of a magnetic amplifier as a control element and a diode with saturating anode current as a detector. Author (NSA)

N67-38947# California Univ., Berkeley. Lawrence Radiation Lab.
EXPERIMENTAL RESULTS OF SELECTION AND BIASING OF FET'S FOR LOW-ENERGY X-RAY AND γ-RAY SPECTROMETERS
Richard C. Jared and George W. Kilian May 1967 14 p refs
(Contract W-7405-ENG-48)
(UCRL-17528) CFSTI: HC $3.00/MF $0.65

The experimental results are shown for the variation of resolution, gate voltage, and transconductance of a field effect transistor by variation of the B plus voltage applied to the drain resistor. A short description of the selection technique of field effect transistors for use in high resolution systems, the preamplifier used, and several spectra showing the resolution obtained are presented. Author

N67-39072*# Western Reserve Univ., Cleveland, Ohio.
ANNUAL STATUS REPORT No. 2, MARCH 1, 1966–FEBRUARY 28, 1966
Karl J. Casper 28 Feb. 1966 48 p refs
(Grant NsG-655)
(NASA-CR-89334) CFSTI: HC $3.00/MF $0.65 CSCL 09A

A summary is presented of research in the following areas: studies of the response functions of lithium drifted silicon detectors to monoenergetic electrons, preliminary investigation of the temperature dependence of the resolution of lithium drifted silicon detectors, fabrication of large volume lithium drifted silicon detectors, studies of the internal Compton effect using a superconducting magnet beta ray spectrometer, ohmic contacts to silicon detectors, and studies of high Z semiconductors for radiation detectors. R.N.A.

N67-39148 Martin Co., Baltimore, Md.
RELIABILITY ANALYSIS AND PREDICTION
C. H. Karr and L. Swanson Nov. 1966 36 p
(Contract AT(30-1)-3607)
(MND-3607-123)

The initial failure modes and effects analysis was made at the component level, where causes and effects were depicted for each given failure mode. Throughout the design phase, and especially in the early stages, efforts have been made to overcome, counteract, or resist those critical modes denoted at the time. The determination of failure modes and effects has also aided in establishing the reliability math model. The latest updated prediction, prediction (3), has factored in actual part stress levels. The computed converter reliability based on catastrophic failures now is apportioned at .825 for an individual power channel, and .989 for at least one power channel, based upon a 1 year orbital mission. Prediction (3) telemetry computations show a probability for success of .792 for an individual discreet half of a telemetry conditioning unit, and .957 for success of at least one half of an operative one, after a period of 1 year in orbit. During the course of the design, strict attention has been given to meeting Reliability Program Plan part qualification requirements. Each critical part and material was selected by the design engineer in consonance with customer, military, and Martin Company guidelines, in light of mission application needs. Author

N67-39162# Hughes Aircraft Co., Fullerton, Calif.
HANDBOOK OF DESIGN CRITERIA FOR MICROELECTRONIC SYSTEM PACKAGES. VOLUME I: PACKAGING SYSTEM METHODOLOGY. VOLUME II: PACKAGING SYSTEM DESIGN AND EVALUATION PROCEDURE Final Report, Nov. 1965–Jan. 1967
Michael A. Merrigan Griffiss AFB, N. Y., RADC, May 1967 193 p
(Contract AF 30(602)-3934)
(RADC-TR-67-125, Vol. I; RADC-TR-67-125, Vol. II; AD-655782)

CONTENTS:

1. PACKAGING SYSTEM METHODOLOGY, VOLUME I p 1–42 (See N67-39163 23-09)

2. PACKAGING SYSTEM DESIGN AND EVALUATION PROCEDURE, VOLUME II p 42–186 (See N67-39164 23-09)

N67-39163# Hughes Aircraft Co., Fullerton, Calif.
PACKAGING SYSTEM METHODOLOGY, VOLUME I
In its Handbk. of Design Criteria for Microelectron. System Packages. Vol. I: Packaging System Methodology. Vol. II: Packaging System Design and Evaluation Procedure May 1967 p 1–42 (See N67-39162 23-09)

This volume identifies the role that packaging plays in enabling electronic circuits to perform as specified under a given set of operational conditions and defines a methodology for use in describing this role. Background information is thus provided to aid the handbook user who may be unfamiliar with some of the terms utilized in defining procedures and categorizing data. As such, Volume I may be used as an introduction to the balance of the handbook or as a reference in clarifying unfamiliar terms encountered during its use. Author

N67-39164# Hughes Aircraft Co., Fullerton, Calif.
PACKAGING SYSTEM DESIGN AND EVALUATION PROCEDURE, VOLUME II
In its Handbk. of Design Criteria for Microelectron. System Packages. Vol. I: Packaging System Methodology. Vol. II: Packaging System Design and Evaluation Procedure May 1967 p 43–166 (See N67-39162 23-09)

This volume establishes a method of defining the design requirements which are most appropriate for controlling the packaging of an electronic system throughout the design cycle, defines a packaging design procedure for use in establishing a design which will be optimized for a particular set of requirements, and describes an evaluation procedure for use in determining the degree to which a particular packaging design complies with a given set of requirements. Step by step procedures are outlined, the considerations involved in accomplishing each step are summarized, and useful data are included or referenced as appropriate to assist in accomplishing the tasks. Thus, this volume may be used to plan and guide effort throughout a system design program. Author

N67-39206# Eidgenoessische Technische Hochschule, Zurich (Switzerland).
INVESTIGATION OF SPONTANEOUS FLUCTUATIONS IN THE APPLICATION OF SEMICONDUCTOR DIODES AS DETECTORS OF NUCLEAR RADIATION
Larry Scott (Ph.D. Thesis) 1966 109 p refs *Its* Dissertation No. 3845
(NP-16827)

After a brief description of the electric and physical properties of diodes used as radiation detectors the following topics are discussed: radiation interactions with solids, noise in diodes, noise analysis of the application of diodes as radiation detectors, and an inexpensive radiation detector system based on the noise measurement technique. NSA

N67-39207# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
BEHAVIOUR OF AN IRRADIATED PHOTOMULTIPLIER [ETUDE DU COMPORTEMENT D'UN PHOTOMULTIPLICATEUR SOUS RAYONNEMENTS NUCLEAIRES]
Robert Verdant Apr. 1967 137 p refs In FRENCH
(CEA-R-3154)

With the aim of using scintillation detectors for the starting-up, the study of transient phenomena, the control or the safety of a nuclear reactor or of a critical assembly, the behavior of 8 photomultipliers (Radiotechnique 51 AVP and UVP, and EMI 9524 B) was studied in the gamma flux of 1 to 10^3 Rh^{-1} in a storage well, and in an EL 2 reactor channel where the exposures varied between 1 to 2×10^3 Rh^{-1} and 6×10^5 to 5×10^7 n. $cm^{-2}\cdot s^{-1}$. Spurious pulses are produced by this radiation at the photomultiplier anode. By comparing the amplitudes of these pulses to those produced by a NaI scintillator, it was observed that their maximum energy level was about 100 keV at 10^3 Rh^{-1} in the gamma flow of the storage well and from 200 to 400 keV at 10^3 Rh^{-1} and 10^7 n. $cm^{-2}\cdot s^{-1}$ in the reactor channel. Furthermore, the detection of a luminous reference pulse corresponding to 200 keV (NaI) is only perturbed at values of above a few hundred Rh^{-1} by the γ radiation alone, and above 5×10^6 n. $cm^{-2}\cdot s^{-1}$ and ≈500 Rh^{-1} in the reactor channel. The dispersion of these results is of the order of 2 for the 8 tubes tested. Author (NSA)

N67-39231# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.
DEVELOPMENT OF A SPECTRAL ANALYZER FOR RADIO-FREQUENCIES [ETUDE ET REALISATION D'UN ANALYSEUR DE SPECTRES POUR RADIO-FREQUENCES]
Jean Bourbigot Apr. 1967 157 p refs In FRENCH
(EUR-3446.f; CEA-R-3216)

An apparatus is described which was designed to show on the screen of a cathode ray tube the amplitude and frequency distribution of the spectral components of a given signal. The frequency range is from 5 kHz to 25 MHz. Two fundamental elements are used in the development of this apparatus, a ferrite and a ring modulator. The basic properties of these elements are studied and discussed. A theoretical study for the determination of the fundamental parameters of the analyzer is presented in the appendix. Author (NSA)

N67-39232# Radio Corp. of America, Princeton, N. J. Conversion Devices Lab.
LOW TEMPERATURE INFRARED PHOTOCONDUCTORS Summary Report, 31 May 1966–30 Jun. 1967
Melvin L. Schultz 22 Aug. 1967 52 p refs
(Contract Nonr-2225(00))
(AD-657445)

Results obtained in the continuation of research directed toward the development of an infrared-sensitive solid-state photoconductive multiplier are reported. The principal effort has been devoted to the investigation of the suitability of amorphous Se as a material of which the carrier-accelerating layer might be made. Such a layer must permit the acceleration of carriers of one sign to energies of the order of 1 eV and, if possible, not transmit carriers of the opposite sign. The selective transport of holes excited by photon absorption in photoconductors in contact with evaporated amorphous Se films has been sought using several different photoconductors. Selectivity, to varying degrees, has been observed in some cases but not in all. Special emphasis has been placed on the use of PbTe as a photoconductor having properties similar to those of PbTe-SnTe or PbSe-SnSe planned for ultimate use. The lack of reproducibility in the transport experiments is felt to be due to uncontrolled variation in properties of the Se films. This is based on an apparent correlation between poor selectivity and abnormally low resistivity of the Se layers. The low resistivity is thought not to be due to conversion of the Se but may be associated with strains due to thermal mismatch on cooling. A method of detection of energetic carriers emerging from a Se layer based on extrinsic impact ionization of Ge:Cu at liq. He temperature has been devised. The first test was inconclusive. Recently, the investigation of Si as a material for the accelerating layer has been started. Author (TAB)

N67-39356# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).
THE FRASCATI MICROTRON [IL MICROTRONE DI FRASCATI]
V. Bizzarri and A. Vignati 12 Jul. 1967 9 p refs In ITALIAN
Its Nota Interna No. 370
(LNF-67/46) CFSTI: HC $3.00/MF $0.65

Magnetic and vacuum characteristics of the Frascati microtron are presented, along with details of its plane conical resonance cavity. Characteristics of the acceleration ring are detailed, including those of the cavity, window, electron gun, and cathode. Some possible uses of the microtron noted are for synchrotron injection and positron ring production as well as in radiology and industry. Transl. by M.W.R.

N67-38377# Harvard Univ., Cambridge, Mass. Div. of Engineering and Applied Physics.
TRANSMISSION-LINE DISTRIBUTED AMPLIFIERS UTILIZING FIELD-EFFECT TRANSISTORS
J. B. Hopkins and A. A. Pandiscio Jul. 1967 337 p refs
(Contract Nonr-1866(16))
(TR-534; AD-657170)

The purpose of this investigation is the determination of operating characteristics of a distributed amplifier utilizing field-effect transistors as active elements and constructed in the form of helical transmission lines. A review of the properties of field-effect transistors is carried out, and the amplifier is analyzed in terms of transmission line equations, taking the input and output lines to be loaded by the FET input and output impedances, respectively. After equations are obtained which characterized such loaded transmission lines, and suitable terminations are described, an overall gain expression is developed, forming the basis of a computer simulation of the amplifier. In addition, general relations concerning design specifications and final amplifier performance are obtained from simple models and checked against the more elaborate simulation. Problems associated with transistor gate-drain (feedback) capacitance are examined in a variety of ways. Pulse response and variation of gain with frequency are investigated by means of the computer simulation for a variety of transistor and amplifier specifications. The construction and testing of experimental amplifiers utilizing both junction and MOS (depletion) FET's is described and shows satisfactory agreement with theory. Bandwidths exceeding 200 Mc. at a gain of two have been achieved, using transistors with a gain-bandwidth product of 50 Mc. The principal limitations found at present are the low transconductance–leading to low gain–and cutoff frequency of currently available FET's. Author

10 ELECTRONICS

Includes circuit theory; and feedback and control theory. For applications see: 09 Electronic Equipment. For related information see: Specific Physics Categories.

N67-38133# City Coll. Research Foundation, New York.
ELECTROSTATIC FOCUSING OF HOLLOW SPIRALING ELECTRON BEAMS Triannual Report No. 1, 1 Nov. 1966–30 Mar. 1967
Morris Ettenberg Jul. 1967 18 p ref
(Contract DAAB07-67-C-0159)
(ECOM-0159-1; AD-655814)

The purpose of this research is to study, experimentally and theoretically, the injection and focusing of hollow electron beams by electrostatic means. In order to accomplish this type of focusing the electrons must have an angular velocity about the focusing electrode which provides them with a centrifugal force. A program has been started to form the cathode for spiraling beam injection by electroforming. It is planned to use this cathode in an end-fire injection scheme. A computer study of electron trajectories under electrostatic focusing including space charge has been initiated. Author (TAB)

N67-38139# Massachusetts Inst. of Tech., Cambridge. Electronic Systems Lab.
THRESHOLD ELEMENTS AND THE DESIGN OF SEQUENTIAL SWITCHING NETWORKS Interim Technical Report, Mar. 1966–Mar. 1967
Alfred K. Susskind, Donald R. Haring, and Chung L. Liu Griffiss AFB, N. Y., RADC, Jul. 1967 316 p refs
(Contract AF 30(602)-3681)
(DSR-74631; RADC-TR-67-255; AD-657370)

The report covers research performed from March 1966 to March 1967. The major topics treated are: (1) methods for finding weight-threshold vectors that realize a given switching function in multi-threshold linear logic; (2) synthesis of sequential machines by means of shift registers and simple variants of that form; (3) an on-line programming system for computer-aided shift-register synthesis of sequential machines; (4) the relationship between finite memory-span and shift-register synthesis; (5) studies of globally universal switching functions; (6) methods for the synthesis of switching networks where signals can have more than two levels; and (7) universal circuit forms for sequential machines. Author (TAB)

N67-38258# Syracuse Univ., N. Y.
A STABILITY THEORY FOR NON-LINEAR DISTRIBUTED NETWORKS
Alan N. Willson, Jr. Griffiss AFB, N. Y., RADC, Jul. 1967 124 p refs
(Contract AF 30(602)-3538)
(EE-1258-5-67; RADC-TR-67-328; AD-657342)

Electrical networks consisting of lumped linear and memoryless non-linear elements and an arbitrary number of lossless transmission lines are considered. It is shown that a large class of such networks may be described by a system of functional differential equations. Several examples of the theory are presented. Author (TAB)

N67-38314# Pennsylvania Research Associates, Inc., Philadelphia.
SELF-REPAIR THEORY INVESTIGATION Quarterly Report, Oct.–Dec. 1966
Edward W. Veitch May 1967 45 p refs
(Contract DA-28-043-AMC-02344(E))
(U67-1027; ECOM-02344-2; QR-2; AD-652280)

The self-repair theory investigation is a study to develop a theory of self repair in digital nets via fault diagnosis and automatic circuit replacement. The technique used is that of the sequential prime implicant form. This report shows how the factoring of the SPIF of the sequential net into sets of covering projections, each projection being a partial description of the net behavior, can be interpreted to include knowledge of impossible failure modes, knowledge of impossible state combinations, and can be used to simplify state transition. Author (TAB)

N67-38398*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN LSI VARIABLE FUNCTION REGISTER
Robert J. Lesniewski Sep. 1967 19 p refs
(NASA-TM-X-55940; X-711-67-488) CFSTI: HC $3.00/MF $0.65
CSCL 09C

A variable function register capable of ten different operations is presently being developed through MOS technology. The register, which uses 500 active devices, can be cascaded to form a large composite register which is capable of functioning as one large

register or as individual registers. This is made possible by electrically altering the characteristics of the register. This allows the variable function register to meet various needs. Author

N67-38404# Stanford Research Inst., Menlo Park, Calif.
CONVERGENCE PROOFS FOR GLUCKMAN'S PROCEDURE Technical Report, Dec. 1966–Aug. 1967
Richard O. Duda Aug. 1967 31 p refs
(Contract Nonr-3438(00))
(AD-657171)

The standard error-correction procedures for training a linear machine terminate as soon as the training patterns have been separated. If the training set is small, the resulting hyperplane boundaries may be undesirably close to some of the patterns. To correct this situation, Glucksman has proposed a new training procedure which requires the boundaries to be at least some minimum distance from all of the training patterns. This report gives convergence proofs for two modifications of Glucksmans procedure. In both cases, the distance delta used during training must be less than the maximum possible distance delta m. For the tw-category case, we show that convergence is guaranteed for any delta < delta m. For the R-category case, we can guarantee convergence if delta is less than some fraction of delta m. The results of applying Glucksmans procedure to two- and ten-category problems using Highleymans data are given. Author (TAB)

N67-38405# Rice Univ., Houston, Tex. Dept. of Electrical Engineering.
MACHINE-ORIENTED LOGIC INCORPORATING THE EQUALITY RELATION
Elbert Ernest Sibert, Jr. (Ph.D. Thesis) May 1967 81 p refs
(Contract AT(40-1)-2572)
(ORO-2572-12) CFSTI: HC $3.00/MF $0.65

A system of first-order logic is developed which is intended to provide a basis for the design of efficient mechanical procedures for proving theorems in whose formulation the equality relation is used. The approach used is based on the fact that the equality relation determines a congruence of the terms and literals arising from a given statement. The system contains three rules of inference, the first of which consists essentially of the application of the resolution principle to congruence classes of literals. The second and third rules are applied only to expressions consisting entirely of equations and denials of equations. The second rule is a rather complicated inference involving a large number of applications of the transitive property of equality; and the third rule is a relatively straightforward application of the universal subetitution property of equality. The system is shown to be complete in the sense that any logically false sentence can be refuted with a finite number of applications of these rules of inference. Some principles for detecting superfluous inferences are also presented, and the completeness of procedures utilizing these principles is demonstrated. Author (NSA)

N67-38443# Royal Aircraft Establishment, Farnborough (England).
A SYSTEM OF PATTERN RECOGNITION INDEPENDENT OF DISPLACEMENT, SCALE AND ORIENTATION
A. K. Edgar Nov. 1966 38 p
(RAE-TR-66367) CFSTI: HC $3.00/MF $0.65

The note describes the theory and gives experimental results for a pattern recognition system. It is shown that recognition is independent of displacement scale and orientation. Further development work is required to improve the system stability and to obtain greater resolution. Author

N67-38718* Santa Clara Univ., Calif. Dept. of Electrical Engineering.
POPOV INEQUALITY VIA PARAMETER PLANE
D. D. Siljak [1967] 5 p refs Presented at the Princeton Conf. on Inform. Sci. and Systems, Princeton, N. J., 30–31 Mar. 1967 Submitted for publication
(Grant NGR-05-017-010)
(NASA-CR-89340) CSCL 09C

A parameter plane interpretation of the Popov inequality which appears in absolute stability analysis of nonlinear systems is presented. The major advantage of the proposed technique over a conventional frequency domain interpretation of the inequality lies in the fact that the influence of system parameters on the absolute stability can be considered by a straightforward procedure. A general computer program is readily available. Author

N67-38818* Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
INVESTIGATION OF OPTIMIZATION OF ATTITUDE CONTROL SYSTEMS Annual Report, 15 Sep. 1965–30 Jun. 1966
30 Jun. 1966 91 p refs Prepared for JPL
(Contracts NAS7-100; JPL-950670)
(NASA-CR-89341; AR-2) CSCL 09C

Optimal control is considered in bounded phase-coordinate processes and for antenna pointing direction subject to random disturbances. For the former problem, both time-optimal control of an unstable booster with actuator position and rate limits and a flexible vehicle subject to wind disturbances are examined. In the flexible vehicle the ratio of actuator position to rate plays an important role in the extremal law, and the control variable is found to enter and exit from its bound as often as time permits. For both examples, results are presented as explicit time functions. Optimal control of antenna pointing direction is studied by keeping direction within an accepted region with maximum probability at all times, and with the controller forcing the antenna to point in a desired direction by minimizing the error rate of information transmission during the space flight. The Markovian property of the random jittering of the antenna is assumed, and the problem is reduced to determining a controller by an iteration procedure. M.W.R.

N67-38867# Case Inst. of Tech., Cleveland, Ohio.
THE STUDY OF COMPLEMENTARY POLYNOMIALS IN A NETWORK SENSE
Harvey R. Algeri Jul. 1967 34 p refs
(Contract AF 19(628)-1699)
(AFCRL-67-0367; SR-18; AD-657047)

Given the polynomial P1 in S, a lossless ladder network with all its transmission zeros at infinity can be associated with it. Another Hurwitz polynomial P2 can be obtained from the denominator of the input impedance of the associated network with one ohm termination. P1 and P2 can be used to specify the properties of the network in terms of the usual impedance functions. When P1 is chosen to be the Butterworth polynomial P2 can be obtained directly from the coefficients of P1 in a very simple manner. Author (TAB)

N67-39167# National Bureau of Standards, Boulder, Colo. Inst. for Basic Standards.
MICROWAVE ATTENUATION MEASUREMENTS AND STANDARDS
Robert W. Beatty 3 Apr. 1967 51 p refs
(NBS-MONOGRAPH-97) GPO: $0.25

A precise way of representing and analyzing an attenuation measurement is presented, which permits more rigorous definitions

and error analyses than were previously possible. The referral of microwave attenuation measurements to standards operating at lower frequencies is discussed with particular attention to the errors in the referral processes as well as the errors in the standards themselves. Standard operating at d-c, audio frequencies, and higher frequencies are included in the discussion. Comments are made on the accuracy and convenience of various methods, and references are given which cover most of the basic and important research in this field. Author

N67-39200 Joint Publications Research Service, Washington, D. C.
CONNECTING DYNAMIC PRODUCTION MODELS INTO SCHEMES
Yu. P. Krivenkov 9 Oct. 1967 10 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 6, 1967 p 1284–1287
(JPRS-42894; TT-67-33520; UDC-519.95) CFSTI: $3.00

The question of connecting dynamic models of production processes possessing individual values of production cycle length and reproduction coefficient into parallel, serial, and complex schemes is investigated. One problem considered involves the aggregation of parallel operating production processes into a single consolidated production process. A satisfactory solution may be obtained if the aggregation is done with allowance for the closeness of production processes in their characteristics. The solution to the problem of connecting individual production processes into serial and complex schemes is derived with allowance for the complicating circumstance which permits feedbacks along the production line. The entire study involves the formulation of optimization problems within the limits of dynamic programming as well as the mathematical theory of optimal processes. R.N.A.

N67-39203# Boeing Scientific Research Labs., Seattle, Wash. Mathematical Research Lab.
ON ENDOMORPHISMS AND CONGRUENCES OF AUTOMATA
Rudolf Bayer Jan. 1967 30 p refs Sponsored in part by Gen. Elec. Found. *Its* Math. Note No. 497
(D1-82-0592)

The interconnections between automorphisms and congruences of automata were considered elsewhere. From a mathematical point of view, however, the theory presented was heavily restricted. In the paper, restrictions are removed and the structure relations between the endomorphisms, automorphisms, and all congruence relations of an arbitrary, not necessarily finite automaton are investigated. It is shown how the symmetries of an automaton carry over to symmetries of the lattice of congruence relations and to symmetries of quotient automata. Closure operations are defined on the sets of endomorphisms and congruence relations. It is shown that in both structures the closed sets form a complete lattice and that these lattices are dually isomorphic. Finally, it is indicated how this purely algebraic theory can be applied to the decomposition of automata in various ways. Author

N67-39216# Sandia Corp., Albuquerque, N. Mex.
DEVELOPMENT OF MATHEMATICAL MODELS OF SEMICONDUCTOR DEVICES FOR COMPUTER-AIDED CIRCUIT ANALYSIS
Marvin Daniel Jun. 1967 48 p refs
(Contract AT(29-1)-789)
(SC-DR-67-479) CFSTI: HC $3.00/MF $0.65

The development and verification of mathematical models which will approximate the electrical characteristics of Zener and/or avalanche and tunnel diodes is presented. These models are compatible with, and designed to be used in, general computer circuit analysis programs. Author (NSA)

N67-39327# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).
PROPOSAL FOR A NEW ORGANIZATION OF DECISION ELECTRONICS IN MULTICOUNTER EXPERIMENTS
E. Schiavuta and F. Soso 22 May 1967 15 p *Its* Nota Interna No. 366
(LNF-67/37) CFSTI: HC $3.00/MF $0.65

Use of fast reliable integrated circuit elements suitable for building multicounter experiments electronics is considered. The aim of discussions is to show that instead of trying to convert the usual modules to integrated circuitry, the logical organization of experimental block schemes can be changed. The result is a new correlation unit that can give, in a time not much longer than required for a coincidence/anticoincidence operation, the most general logic function of variables. The unit can be computer programmed. This performance, unattainable from conventional modules, seems simple enough to be obtained from integrated elements and offers improvement of logic flexibility at little cost and complexity increase. S.P.

N67-39372 Joint Publications Research Service, Washington, D. C.
VARIABLE-STRUCTURE AUTOMATA
G. A. Agasandyan 5 Oct. 1967 5 p refs Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 174, no. 3, 1967 p 529–530
(JPRS-42839; TT-67-33465) CFSTI: $3.00

Mathematical expressions are briefly discussed for representing neurophysiological problems for automata. Two theorems are mentioned and examples are given. N.E.N.

11 FACILITIES, RESEARCH AND SUPPORT

Includes airports; lunar and planetary bases including associated vehicles; ground support systems; related logistics; simulators; test facilities (e.g., rocket engine test stands, shock tubes, and wind tunnels); test ranges; and tracking stations.

N67-38187# Dayton Univ., Ohio.
THE AIR FORCE MATERIALS LABORATORY TERMINAL BALLISTIC RESEARCH FACILITY
Harold H. Hunt and Robert F. Roisten Wright-Patterson AFB, Ohio, AF Mater. Lab., Jul. 1967 26 p refs
(Contract F33615-67-C-1087)
(AFML-TR-67-188; AD-657378)

The ballistic research facility described in this report was installed at Wright-Patterson Air Force Base for the Air Force Materials Laboratory by the Research Institute, University of Dayton. The facility has a capability for launching conventional small arms projectiles and simulated fragments with controlled velocities at targets of materials under investigation. Still cameras with high intensity, short duration (0.6 microsecond), light sources and high speed framing cameras provide photographic coverage of the impact event. Equipment has been provided to apply or simulate external stresses to a sheet or structural target during impact. Author (TAB)

N67-38309# California Univ., Berkeley. Lawrence Radiation Lab.
THEORY OF THE RF MANIFOLD AND MEASUREMENTS ON A MODEL MANIFOLD SYSTEM
Ferdinand Voelker Apr. 1967 51 p refs
(Contract W-7405-ENG-48)
(UCRL-17508)

A system is proposed to distribute rf energy to a linear accelerator from an adjacent manifold. This system is described and a simple theory is developed to show that the voltage will be locked in the various load cavities. A method is developed to predict the frequency of adjacent modes. Various predicted values are compared with experimental results from a model rf manifold. Author (NSA)

N67-38347*# Ohio River Div. Labs., Cincinnati.
FULL SCALE CRAWLER BELT SHOE TESTS—SURFACE EFFECTS
Apr. 1967 61 p refs
(NASA Order CC-15162)
(NASA-CR-88984; TM-2-64) CFSTI: HC $3.00/MF $0.65 CSCL 22D

A qualitative evaluation is made of the materials and methods being considered for remedial construction of the crawler way pavements for Launch Pads A and B of Lunar Launch Complex 39 at the John F. Kennedy Space Center. The materials and surfacing are described and are evaluated through simulated loading with a full scale crawler belt shoe from the crawler transporter. The results of these studies have indicated the most feasible of the surfacing materials evaluated both from the standpoint of structural stability and desirable friction characteristics when used with a special lubricant. Further full scale studies of this surfacing material are recommended for tests under the operation of the fully loaded crawler transporter. Author

N67-38381*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
DYNAMIC FLIGHT BEHAVIOR OF A BALLASTED SPHERE AT MACH NUMBERS FROM 0.4 TO 14.5
Barbara J. Short Washington, NASA, Oct. 1967 34 p refs
(NASA-TN-D-4198) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A ballasted sphere with a static margin of 14 percent of the diameter was tested at Mach numbers from 0.4 to 14.5 and Reynolds numbers between 0.4×10^6 and 1.6×10^6. It was found to be dynamically unstable. At supersonic and hypersonic speeds the oscillatory motions were orderly and the static stability was predictiable. At low speeds the angular motions were erratic and so were the characteristics of the boundary layer as it separated from the body to form the wake. Author

N67-38392# Naval Ordnance Lab., White Oak, Md.
WIND TUNNEL FREE-FLIGHT TESTING TECHNIQUES FOR PLANAR MOTION EMPLOYED AT THE NAVAL ORDNANCE LABORATORY
Algrid P. Leonas and Frank J. Regan 3 May 1967 44 p refs
(Aerodynamics Res. Rept.-279; NOLTR-67-69; AD-656903)

The report is a summary of the planar motion free-flight testing techniques and procedures employed at the Naval Ordnance Laboratory, White Oak, Maryland. It is intended primarily to aid in standardizing the testing procedure and as a guide for further development in this field. Author (TAB)

N67-38539# United Kingdom Atomic Energy Authority, Culham (England). Culham Lab.
A MAGNETIC ION INJECTION CHANNEL
A. L. Bezbatchenko and E. I. Sadovskii Feb. 1967 17 p Transl. into ENGLISH from IAE-1099 report
(NP-tr-1535; IAE-1099; CTO-371) CFSTI: HC $3.00/MF $0.65

A magnetic channel for injecting hydrogen ions with energies to 160 keV into a magnetic field up to 3,500 Oe in "Ogra" through an angle between 0 and 35° to the plane perpendicular to the axis of the trap is described. It consists essentially of a bent steel tube of rectangular cross section, and fitted with a compensating and a deflecting coil. It can be heated to 400°C together with the vacuum vessel. Author (NSA)

N67-38789# Princeton Univ., N. J. Plasma Physics Lab.
TURN-TO-TURN VOLTAGE TESTERS DEVELOPED FOR MAGNET COILS
C. W. Bushnell and H. G. Johnson *In its* Plasma Phys. Lab. May 1967 p 379–385 (See N67-38725 23-25)

Two types of voltage testers were developed for leakage testing on insulated electrical coils and windings. One test device contains a high voltage capacitor that discharges into the coil and induces voltage oscillations across coil terminals for analysis; the other tester uses a power oscillator to excite the coil at its self-resonant frequency to the desired level. Coil characteristics are determined by: (1) comparison of resonant frequency and coil Q at high and low voltage levels and with other identical coils; (2) the absence of any sudden impedance change in the coil as the voltage is raised; and (3) voltage distribution characteristics. G.G.

N67-38772# Princeton Univ., N. J. Plasma Physics Lab.
ION CYCLOTRON RESONANCE HEATING REVISIONS FOR MODEL C
V. S. Foote and A. J. Sivo *In its* Plasma Phys. Lab. May 1967 p 393–400 refs (See N67-38725 23-25)

The ion cyclotron resonance heating circuitry was redesigned to reduce the probability of arcing in the C stellarator. The coupling circuit was modified by using voltage and current standing waves at the transmission line terminal to balance radio frequency voltages. By the proper choice of dimensions, maximum current and minimum voltage were then placed in the region where plasma heating took place. This revised ICRH equipment reached a peak power level of 4 megawatts with a pulse length of 5 milliseconds at a loaded Q of 80. G.G.

N67-38776# Princeton Univ., N. J. Plasma Physics Lab.
THE LINEAR MULTIPOLE MACHINE (LM-1)
C. W. Bushnell *In its* Plasma Phys. Lab. May 1967 p 422–427 (See N67-38725 23-25)
(Grant NSF GP-579)

The basic components of the linear multipole machine are described briefly. Two current carrying bundles, the "Q lines", produce a quadrupole field and carry up to 60,000 amperes on a pulse basis or up to 15,000 amperes continuously. The vacuum system contains twenty experimental ports and reaches a base pressure in the middle 10^{-8} torr range. Breakdown and ohmic heating as well as an electron cyclotron resonance oscillator system are available for plasma heating and will provide 10 kW at 10.5 GHz. G.G.

N67-38777# Princeton Univ., N. J. Plasma Physics Lab.
MINIPOLE MACHINE
J. G. Murray *In its* Plasma Phys. Lab. May 1967 p 428–432 (See N67-38725 23-25)

The construction of a toroidal quadrupole plasma generating machine is described. This vacuum seal construction employs O

rings and its internal coils are insulated with epoxy and teflon. The quadrupole windings consist of two 10-inch coils of solid copper wire wound on a phenolic torus supported by stainless steel rods. A coaxial feed provides power pulses of 500 volts at 500 amperes with a top of .8 milliseconds. The injected gas is ionized between charged plates inside the vacuum vessel, and the two coaxial external field coils around the vacuum vessel can be adjusted for desired spacings. G.G.

N67-38778# Princeton Univ., N. J. Plasma Physics Lab.
THE PRINCETON UNIVERSITY CYCLOTRON
R. G. Mills *In its* Plasma Phys. Lab. May 1967 p 433–436 (See N67-38725 23-25)

Design and engineering efforts for a proposed sector-focusing isochronous, or azimuthally varying field cyclotron are depicted. The projected plasma generating machine will provide a frequency range of 13.5 to 26 MHz. Currently the building to house the machine is under construction and completion of all machine systems, their installation and adjustment proceeds according to schedule. G.G.

N67-38830# California Univ., Berkeley. Lawrence Radiation Lab.
BEVATRON OPERATION AND DEVELOPMENT. 83, JANUARY–MARCH 1967
Robert W. Allison, Kenneth C. Crebbin, and Robert Frias 2 Jun. 1967 12 p refs
(Contract W-7405-ENG-48)
(UCRL-17543) CFSTI: HC $3.00/MF $0.65

Repair work on the main motor generators continued through this quarter. Construction work was started for the foundation and shielding of the new two-channel external proton beam system. The Bevatron main control room was expanded to provide additional console space to handle the increasingly complex experimental program and beam-sharing problems. The Bevatron magnet sectors were realigned on a new tilted plane to return the closed orbit to the gap center line. Repairs were made on parts of the injector system. Measurements of the linac E and wall H fields were made. Author (NSA)

N67-38885# Naval Research Lab., Washington, D. C.
EFFECT OF SHOCK OVER PRESSURES ON HIGH EFFICIENCY FILTER UNITS
W. L. Anderson and T. Anderson (Naval Ordnance Lab.) *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 79–95 refs (See N67-38880 23-22)

Overpressure shock resistance of the fire-resistant filter units in use in reactor systems today is compared to the shock resistance of the older combustible units. The filter unit shock studies are summarized. The effects of foam adhesives, dust loading, and wire cloth facing are discussed. NSA

N67-38929* Scientific Translation Service, La Canada, Calif.
DESIGN OF A LIGHT-GAS GUN WITH A LIGHT PISTON [RASCHET LEGKOGAZOVOY PUSHKI S LEGKIM PORSHNEM]
S. N. Palkin and B. I. Resnikov Washington, NASA, Oct. 1967 12 p refs Transl. into ENGLISH of the Publ. "Aerofizicheskiye Issledovaniya Sverkhzvukovykh-Techenii" Moscow, Izd. Nauka, 1967 p 210–218 Presented at the IAS Hypersonic Tech. Symp., Denver, Oct. 1960
(Contract NASw-1496)
(NASA-TT-F-11310) CSCL 14B

Description of a method of designing a light-gas gun with a light piston by successive computation of the parameters of the various parts of the gun. The construction of the gun consists of a combustion chamber from which pressure is exerted on a plastic or aluminum piston in a compression chamber. The pressure created by the movement of the piston in the compression chamber acts on a missile in the gun barrel. The problem of the piston velocity is theoretically evaluated. The necessary gas parameters in the compression chamber are computed, and the resulting missile velocities are analyzed. The approximate values gained by these relationships are utilized for the computation of the overall gun parameters. The dependence of the piston velocity on the gas parameters in the combustion and compression chambers is described. The dependence of the missile velocity on the piston velocity and on the starting pressure in the compression chamber is also discussed. Author

N67-38979# Israel Program for Scientific Translations, Ltd., Jerusalem.
EXPERIMENTAL CHECK OF PROTECTION CALCULATIONS FOR ELECTRON ACCELERATORS
I. P. Korenkov *In its* Dosimetry and Radiation Protect. 1966 p 103–104 refs (See N67-38961 23-24)

The results of some theoretical calculations of electron accelerator shielding are reported. The data are compared with experimental radiation monitoring for a 2.5 MeV electron accelerator with 160 μA mean current at a tungsten target of optimal thickness. NSA

N67-39034 Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany). Inst. fuer Strahlantriebe.
INVESTIGATIONS ON A THREE-STAGE HOT WATER EJECTOR WITH FIXED MIXING TUBE DIMENSIONS [UNTERSUCHUNGEN AN EINER DREISTUFIGEN HEISSWASSERSTRAHLPUMPE MIT FESTEN MISCHROHRABMESSUNGEN]
R. Lindemann and E. Riester Apr. 1967 26 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-40)

A test facility for three-stage hot water ejectors is described. For an ejector combination with fixed geometrical dimensions of each stage, the suction pressure and the necessary hot water flow rate are given as a function of the air flow rate. After several minutes of running time, the performance of the aggregate was reduced by a layer of ice in the first stage. Steps for preventing the ice deposition are suggested. Author

N67-39040 College of Aeronautics, Cranfield (England). Dept. of Aerodynamics.
THE COLLEGE OF AERONAUTICS WHIRLING ARM INITIAL DEVELOPMENT TESTS
P. E. Kumar May 1967 14 p refs
(Contract PD/28/016)
(CoA-Aero-174)

The old whirling arm of the National Physical Laboratory has been re-erected to provide a facility for the study of ground effect on wings, and other craft operating near the ground. The model is mounted on struts, which differ considerably from those used by NPL, and moves over an adjustable floor in a specially constructed channel. This note covers the initial tests conducted on the arm towards making it a fully operational facility. It is concluded that a full yaw mater survey is necessary to define the air flow existing in the channel, during operation of the arm, and that the instrumentation being used needs to be further developed. Author

N67-39071*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
FACILITIES FOR SIMULATING ATTITUDE MOTION OF SPACECRAFT
Herbert H. Hoop Redstone Arsenal, Ala., Redstone Sci. Inform. Center., 30 Jun. 1967 48 p refs Prepared jointly with Army Missile Command
(NASA-TM-X-60442; RSIC-679) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report describes facilities using gas bearings in attitude motion simulators for the development of spacecraft attitude control systems. Typical facility information includes discussions on test chamber, bearing, platform, power requirements, balance consideration, testing procedure, attitude reference sources, sensors, and data transmission. Facilities at twelve Government and industrial organizations are discussed. Author

N67-39085* National Aeronautics and Space Administration, Washington, D. C.
TECHNICAL FACILITIES CATALOG, VOLUME II
Mar. 1967 580 p
(NHB-8800.5, Vol. II) CSCL 14B

Resumes are presented for research, development, test, and evaluation facilities located at or affiliated with the following installations: Kennedy Space Center, Manned Spacecraft Center, and Marshall Space Flight Center. Data includes brief technical descriptions, plans and costs, cognizant organizational components, and capabilities and functional information. Environmental test chamber and wind tunnel summary charts are also presented. E.C.

N67-39086* National Aeronautics and Space Administration, Washington, D. C.
TECHNICAL FACILITIES CATALOG, VOLUME I
Mar. 1967 616 p
(NHB-8800.5, Vol. I) CSCL 14B

Research, development, test, and evaluation facilities are summarized. Facility resume data presented includes brief technical descriptions, plans and cost data, cognizant organizational components, and capabilities and functional information. Environmental test chamber and wind tunnel summary charts are included. This volume contains resumes for facilities located at or affiliated with the following installations: Ames Research Center, Electronics Research Center, Flight Research Center, Langley Research Center, Lewis Research Center, Space Nuclear Propulsion Office-Nevada, Goddard Space Flight Center, Jet Propulsion Laboratory, and Wallops Station. E.C.

N67-39209*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
THE USE OF A CONVENTIONAL WIND TUNNEL AS A MULTIGAS FACILITY
Howard Koester, Gilbert Herrera, and Donald Hanks 8 Apr. 1963 18 p
(Contract NAS7-100)
(NASA-CR-89331; JPL-TM-33-145) CFSTI: HC $3.00/MF $0.65 CSCL 14B

This report presents the results of utilizing the Jet Propulsion Laboratory 21-in. hypersonic and 20-in. supersonic wind tunnels as continuous flow multigas facilities. Carbon dioxide (CO_2) was used as the contaminating gas. Concentrations up to 70% by volume of CO_2 were obtained at Mach numbers 2.8 and 6.0. The techniques, special equipment, instrumentation used, and results are discussed. This study is of particular interest since aerodynamic testing in atmospheres approximating those of Venus and Mars appears to be feasible in facilities originally designed to use air as the working fluid. Author

N67-39230# Oak Ridge National Lab., Tenn.
A SURVEY OF OPTIMUM DUAL-PURPOSE DESALTING PLANTS AS A FUNCTION OF PRODUCT RATIO USING ALTERNATE STEAM SUPPLIES
D. M. Eissenberg and C. C. Burwell Jul. 1967 290 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1659) CFSTI: HC $3.00/MF $0.65

The results of a computer comparison of the total annual costs of over 1800 dual-purpose plants based on a consistent set of ground rules and cost bases are presented. The design and cost relationships that arise from the coupling of the three components of the dual-purpose plant—energy source, turbogenerator, and distillation plants for the production of large quantities of both electric power and desalted water are examined parametrically. Dual plant cost and design characteristics are determined for a range of values for each of the major parameters of product ratio, water plant size, prime steam cost, capital charge rate, and prime steam conditions. The effect of maximum brine temperature and of off-optimum performance ratio on dual plant annual costs are determined holding most of the parameters constant. A comparison of the value to dual-purpose plants of steam at five different prime steam conditions is included. 12 references. NSA

N67-39347 Centre National de la Recherche Scientifique, Meudon (France). Lab. d'Aerothermique.
CONTINUALLY OPERATING SR3-B HYPERSONIC WIND TUNNEL FOR RAREFIED GAS STUDIES [SOUFFLERIE HYPERSONIQUE SR3-B A GAZ RAREFIE ET A FONCTIONNEMENT CONTINU]
Jean Allegre and Michel Raffin Jul. 1967 38 p refs In FRENCH
(Rept.-67-3; Publ.-295)

While conducting aerodynamic and thermal measurements of rarefied gases at very high speeds and elevated Knudsen numbers, the SR3 wind tunnel was converted to a hypersonic wind tunnel and designated SR3-B. This permitted studies at Mach numbers between 15 and 20 as well as at very high static pressure flow. Fed by pure nitrogen, the wind tunnel functions continually in a free stream. The isentropic measurements reached 16 cm for a nozzle outlet of 36 cm. Both a description of the installation and some preliminary wind tunnel measurements are included. Transl. by M.W.R.

12 FLUID MECHANICS

Includes boundary-layer flow; compressible flow; gas dynamics; hydrodynamics; and turbulence. For related information see also: 01 Aerodynamics; and 33 Thermodynamics and Combustion.

N67-38070# New York Univ., N. Y.
OPERATION INSTRUCTIONS AND DESCRIPTION OF COMPUTER PROGRAM FOR FINITE DIFFERENCE SOLUTIONS OF THE LAMINAR COMPRESSIBLE BOUNDARY LAYER EQUATIONS IN THE VON MISES VARIABLES Interim Scientific Report
Faiza Nabi Wright-Patterson AFB, Ohio, ARL, May 1967 78 p ref
(Contract AF 33(615)-2215)
(NYU-AA-66-59; ARL-67-0098; AD-657322)

The report is designed to give a detailed description of the numerical solution of a compressible boundary layer. It presents

the methods of operation as well as the listing and flow chart of the programming so as to enable the user to perform some changes if necessary. The program, henceforth referred to as DORITH, is written in FORTRAN II language and has been operated at both IBM 7094 and CDC 6600 installations. It occupies (44500) sub 8 = (18752) sub 10 memory locations and requires the system subroutines SQRTF and ABSF. Author (TAB)

N67-38257# Naval Ordnance Lab., White Oak, Md.
AN ANALYTICAL INVESTIGATION OF THE FLAT PLATE TURBULENT BOUNDARY LAYER IN COMPRESSIBLE FLOW
Neal Tetervin 15 May 1967 141 p refs
(NOLTR-67-39; Aerodynamics Res. Rept.-286; AD-657456)

The concepts of eddy kinematic viscosity and eddy diffusivity are used to calculate skin friction and heat transfer coefficients for the turbulent boundary layer on a flat plate. The eddy kinematic viscosity, eddy diffusivity, and turbulent Prandtl number vary across the boundary layer. The Mach number range is from zero to ten. The surface to stream temperature ratio varies from one-half to eight, and includes the insulated surface. The friction results are compared with experimental data. Velocity and temperature profiles for the entire region from the surface to the outer edge are compared with experimental data. Author (TAB)

N67-38273*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
SPECTRUM OF PRESSURE FLUCTUATIONS IN A TURBULENT FLOW
E. A. Novikov Redstone Arsenal, Ala., Redstone Sci. Inform. Center, May 1966 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. Atmosfery i Okeana (USSR), v. 1, 1965 p 992–993 Sponsored jointly with Army Missile Command
(NASA-TM-X-60395; RSIC-547) CFSTI: HC $3.00/MF $0.65 CSCL 20D

Calculations are made of the pressure spectrum in a turbulent flow, assuming the flow to be generated by a random intermittent function. The spectrum obtained on the basis of this assumption is found to differ greatly from a spectrum obtained previously on the basis of Millionshchikov's hypothesis of quasi-normality. Author

N67-38289# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
LAWS GOVERNING THE FLOW OF GASES THROUGH POROUS MEDIA [LOIS DE L'ECOULEMENT DES GAZ A TRAVERS LES MILIEUX POREUX]
Soubbaramayer Jun. 1967 42 p refs In FRENCH
(CEA-BIB-91)

Methods of calculating the rate of flow of a gas through a porous media are reviewed. The porous material can be replaced either by a "capillary" model either by a "bed of spheres" model. In the capillary model the theory is derived using simple kinetic theory of gases while in the bed of spheres model one solves the Boltzman equation by the random walk approach or by the well known Chapman–Enskog expansion method. Author (NSA)

N67-38335 Atomic Energy Establishment, Winfrith (England). Reactor Development Div.
A REAPPRAISAL OF SILVER'S MODEL FOR SATURATED WATER FLOW THROUGH NOZZLES
E. Rushton and D. C. Leslie Jul. 1966 25 p refs
(AEEW-M-732)

A model for steam formation by surface evaporation originally proposed by Silver has been investigated. Silver solves the heat conduction equation for a jet by assuming a linear temperature variation confined to a thin skin near the surface: this is shown to be well justified for small voidages. He further assumes that the surface temperature of the jet at the inlet is equal to the supersaturated temperature of the liquid, whereas we find it more natural to assume that the surface of the jet is at its saturation temperature. Finally Silver's model uses several mathematical approximations in solving the governing integral equations. These provide a good approximation at moderate voidages but wrongly imply the existence of a critical pressure. Author

N67-38360*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL INVESTIGATION OF BOUNDARY-LAYER TRANSITION ON A COOLED 7.5° TOTAL-ANGLE CONE AT MACH 10
Philip E. Everhart and H. Harris Hamilton Washington, NASA, Oct. 1967 37 p refs
(NASA-TN-D-4188) CFSTI: HC $3.00/MF $0.65 CSCL 20D

An experimental investigation of boundary-layer transition was conducted on a cooled 7.5° total-angle cone at a free-stream Mach number of 10 and a free-stream unit Reynolds number range of 0.4×10^6 to 2.2×10^6 per foot (1.3×10^6 to 7.2×10^6 per meter). Local unit Reynolds numbers from 0.7×10^6 to 3.1×10^6 per foot (2.3×10^6 to 10.2×10^6 per meter) were obtained at a local Mach number of approximately 9. At a local Mach number of approximately 9, transition Reynolds number was found to be essentially independant of wall temperature for the ratios of wall temperature to adiabatic wall temperature of the investigation. Local transition Reynolds number increases with local unit Reynolds number. The increase in transition Reynolds number (based on the end of transition) with local Mach number that has been noted at moderate supersonic Mach numbers continued to a local Mach number of approximately 9. Author

N67-38368*# Brown Univ., Providence, R. I.
TRANSIENT RADIATION AND CONDUCTION IN A SLOTTED SLAB AND A HOLLOW CYLINDER
P. D. Richardson and Y.-M. Shum Washington, NASA, Oct. 1967 62 p refs
(Grant NGR-40-002-012)
(NASA-CR-905) CFSTI: HC $3.00/MF $0.65 CSCL 20M

Temperature distributions in a parallel walled channel (a typical slot in a slotted slab) and in a hollow cylinder are considered. Each end of the channel or cylinder faces an environment of uniform but alterable temperature. Black wall surfaces are assumed, and for most solutions presented the radiant heat flux is linearized with respect to temperature. Transient solutions are obtained for cases where the walls are thin, and where they are (thermally) thick; in the latter case, transient conduction normal to the wall surfaces is coupled into the problem. Examples of superposition are given. For the hollow cylinder, prescribed heat generation along the wall is also treated. The concept of the radiation mean free effective path is found to be useful. Generalization of nonblack surfaces is discussed. Author

N67-38389# RAND Corp., Santa Monica, Calif.
THE FORCES ON TWO SPHERES IN STOKES FLOW
M. H. Davis Aug. 1967 24 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5357-PR; AD-657008)

An analysis was made of the hydrodynamic forces on cloud droplets with radii less than 30 microns near each other in a viscous fluid. Previous work solved the problem for velocities parallel to the line of centers of the droplets; the study considers the far more complex case of motion perpendicular to that line. The Stokes linearized hydrodynamic theory is used, extending Hockings analysis of nonrotating spheres to spheres that are assumed to rotate freely enough to nullify the torques that would be produced by fluid shear. Velocity expressions were constructed in terms of spherical harmonics centered on each of the spheres. The linear system of an infinite number of algebraic equations in an infinite number of unknowns was truncated to finite size. The forces and torques were evaluated, and the forces were superposed, according to the Stokes procedure, to obtain the force under a condition of rotation such that the torque on each sphere was zero. Reasonably reliable force calculations are feasible at separations down to 0.1 of the radius of the larger droplet; beyond that, the results are numerically unstable. Above 0.5 separation, results are the same as Hockings approximations. Author (TAB)

N67-38424*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

FREQUENCY RESPONSE OF FORCED-FLOW SINGLE-TUBE BOILER WITH INSERTS

Jack H. Goodykoontz, Grady H. Stevens, and Eugene A. Krejsa Washington, NASA, Oct. 1967 39 p refs

(NASA-TN-D-4189) CFSTI: HC$3.00/MF$0.65 CSCL 20D

Frequency response data, in terms of boiler inlet impedance, were obtained for a forced flow single tube boiler with inserts. The flow rate of the test fluid was sinusoidally varied about a mean value. Magnitudes and phase angles of the pressure and flow perturbations were measured at the boiler inlet. The test section was a shell and tube heat exchanger with a plug and spring in the subcooled liquid region and a spirally wound spring in the two phase region. Freon-113 was the test fluid. The inner tube had an inside diameter of 0.430 inch (1.09 cm) and a heated length of 32 inches (81.3 cm). Hot water flowed countercurrent to the Freon flow in the annulus between the inner and outer tubes. The boiler inlet impedance had a negative real part over some frequency range for exit vapor qualities greater than about 40 percent. The boiler became unstable when the feedline resistance was reduced and made equal to the magnitude of the boiler impedance at -180° phase angle. Author

N67-38433# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

APPROXIMATE METHOD OF DETERMINING THE CONCENTRATION FIELD IN A TURBULENT GAS JET

K. A. Malinovskii 7 Jun. 1967 11 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Mekhan. Zhidkosti Gaza (USSR), no. 1, 1967 p 110–112

(Contract NOw-62-0604-c)

(TG-230-T527; TT-67-62662; AD-657163)

A technique is developed for determining the concentration field of the components of a turbulent gas flow from the temperature field in the mixture. The given procedure simplifies determination of the turbulent mixing intensity. Author (TAB)

N67-38612*# National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

PRESSURES AND FORCES ON FLARE-STABILIZED BODIES IN AIR AND IN A MIXTURE OF 85-PERCENT CO_2 AND 15-PERCENT AIR

Gene P. Menees Washington, NASA, Oct. 1967 23 p refs

(NASA-TN-D-4196) CFSTI: HC$3.00/MF$0.65 CSCL 01A

The effect of gas composition on the aerodynamic characteristics of flare-stabilized bodies was studied experimentally. Pressure distributions were obtained on flare-stabilized cylinders with three different nose shapes. The tests were made at Mach numbers of 5.2 and 7.4 in air and 5.7 in a mixture of 85-percent CO_2 and 15-percent air. The nose shapes were a 22-1/2° half-angle cone, a hemisphere, and a near ellipsoid. The flare was a frustum with a cone angle of 16.5°. So that the experimental results could be compared directly with inviscid theories, most of the pressure data were measured with a gap between the flare and the body to bleed off the boundary layer at the flare-cylinder junction. This technique eliminated large regions of flare-induced flow separation on the cylindrical bodies. The results of the present study showed that the aerodynamic coefficients were essentially the same in air and in the CO_2–air mixture for all test models, both with and without flow separation. Predictions made with various inviscid theories agreed well with the experimental results for the conical and hemispherical-nosed models but were not in good agreement with the results for the near ellipsoidal-nosed model. Author

N67-38639# Los Alamos Scientific Lab., N. Mex.

DETONATION SPIN IN DRIVEN SHOCK WAVES IN A DILUTE EXOTHERMIC MIXTURE

Garry L. Schott [1967] 6 p refs Presented at the 154th Natl. Meeting of the Am. Chem. Soc., Chicago

(Contract W-7405-ENG-36)

(LA-DC-8814; CONF-670904-5) CFSTI: HC$3.00/MF$0.65

Occurrence of instabilities in shock waves in a mixture of 1% C_2H_2, 1.5% O_2, 97.5% Ar were studied. Conditions are identified where the phenomena exhibit the recognizable and quasi-reproducible form of single-headed spin. Experiments were conducted in a 10 cm ID circular brass shock tube. Brass shim stock or Mylar sheet diaphragms with H driver gas. A raster oscilloscope recorded the wave speeds. An attempt was made to relate some parameters of the observed single spinning waves to known properties of the chemical mixture. The single-headed spin which may be universally associated with unsupported detonations at the limits of their ability to propagate, is not exclusively a property of unsupported waves or of Chapman–Jouguet flow. NSA

N67-38685# Southampton Univ. (England).

EFFECTS OF CERTAIN ENERGY TRANSFER PROCESSES ON POPULATION DISTRIBUTIONS IN EXPANDING GAS FLOWS

K. N. C. Bray and N. H. Platt *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 59–110 refs (See N67-38681 23-06)

An inert gas is expanded rapidly and continuously from a high temperature. It contains small quantities of a seed atom, which emits resonance line radiation and also forms positive ions and free electrons. In addition, the gas contains small quantities of diatomic molecules which are partly dissociated and also relax vibrationally. Three aspects of the general problem treated in detail are: (1) the trapping of resonance-line radiation, emitted in the hot, dense part of the flow and subsequently absorbed further downstream, (2) factors affecting the electron temperature, including electron drift, induced electric field, inelastic collisions and radiation, and (3) factors affecting the distribution of vibrational energy, including vibrational anharmonicity, atomic recombination and vibration–vibration exchange. A relation is suggested between the rapid relaxation of the anharmonic upper vibrational energy levels of diatomic gases and the anomalous relaxation rates measured in expanding flows. Author

N67-38694# Princeton Univ., N. J.
SUPERSONIC NOZZLE BEAMS—SOME RECENT EXPERIMENTAL RESULTS
N. Abuaf, J. B. Anderson, R. P. Andres, and J. B. Fenn *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 339–361 refs (See N67-38681 23-06)
(Contracts Nonr-3623(00); AF 19(628)-3887; Grant NSF GK-655)

The important features of nozzle beams and their behavior are summarized briefly, and uses of nozzle beams as probes and of velocity analysis are described. It is pointed out that molecular beam probing of freely expanding nets appears to be a powerful tool in the study of various kinds of relaxation rates. The high energies obtainable by nozzle sources and the expansion of gas mixtures is emphasized. The relations governing the beam translational kinetic energy are presented. Effusive flow, jet flow expanded with constant specific heat to high Mach number, and aerodynamic acceleration of heavy molecules by a light gas are considered. Velocity measurements for various mixtures of gases are tabulated and graphed. N.E.N.

N67-38714# Sandia Corp., Albuquerque, N. Mex.
A NUMERICAL SOLUTION FOR THE FLOW FIELD OF A SUPERSONIC CONE-CYLINDER ENTERING AND LEAVING A BLAST SPHERE DIAMETRICALLY
Roger R. Eaton and Glen W. Zumwalt (Oklahoma State Univ.) May 1967 109 p refs
(Contract AT(29-1)-789)
(SC-CR-67-2532) CFSTI: HC $3.00/MF $0.65

An analysis was performed to develop a method by which the flow field about a cone-cylinder configuration could be defined as it entered into and exited from a large radius spherical blast diametrically. The flow was approximated by solving the controlling partial differential equations using a numerical technique first proposed by V. V. Rusanov and extended here to account for real gas effects. Boundary conditions were developed for a 13.347-degree half-angle cone-cylinder which entered and exited from a shock front of strength 22.05 pressure ratio. The stream Mach number of the various phases ranged from 1.7 to 6.9. It was found that the flow in question could be approximated by the numerical technique, although the accuracy of the results decreased as the free-stream Mach number increased. Author (NSA)

N67-38781# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
PHYSICAL GAS DYNAMICS, HEAT TRANSFER AND THERMODYNAMICS OF HIGH TEMPERATURE GASES (SELECTED ARTICLES)
20 Jan. 1967 97 p refs Transl. into ENGLISH from the publ. "Fizicheskaya Gazodinamika. Teploobmen i Termodinamika Gazov Vysokikh Temperatur" USSR, AN SSSR, Energ. Inst., 1964, p 55–68, 80–99, 115–137, and 150–156
(FTD-HT-66-363; TT-67-62287; AD-655034)

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6. A STUDY OF GAS FLOW IN A SHOCK TUBE USING TOEPPLER'S METHOD AND HIGH-SPEED PHOTOGRAPHY V. P. Ionov, G. N. Nikolayev, M. V. Gusev, and O. I. Lunova p 62–77 refs (See N67-38787 23-12)

7. MEASUREMENT OF THE VELOCITY OF SHOCK WAVES IN RARIFIED GASES G. L. Kabanov p 78–89 refs (See N67-38788 23-12)

N67-38783# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
EFFECT OF DISSIPATION ON THE FLOW PARAMETERS BEHIND A SHOCK DISCONTINUITY IN A SHOCK-TUBE [VLIYANIYE DISSIPATSII NA PARAMETRY POTAKA ZA SKACHKOM V UDARNOY TRUBE]
T. V. Bazhenova, I. M. Naboko, and O. A. Predvoditeleva *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 9–28 refs (See N67-38781 23-12)

A phenomenon of variation of a shock wave velocity along a shock tube is considered; such variation is the consequence of the gas state in the flow between the shock wave and the contact front. Various factors affecting the gas parameters behind a shock wave are studied. A brief survey of the available literature on shock wave attenuation and contact-front acceleration is presented, showing that tube walls make a substantial difference in the one-dimensional theory of shock waves. The possibility of calculation of the flow parameters behind a shock wave is investigated on the basis of the available solution for the flow in a shock tube, taking the laminar boundary layer effect into account. Gas parameters along the length of the shock tube are obtained from the shock velocity–variation function. Experimental measurements are compared with the theoretical values of shock wave velocity, and the deviations are discussed. Author

N67-38784# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LOSSES ON REFLECTION OF SHOCK WAVES FROM THE END-PLATE IN A SHOCK TUBE [POTERI PRI OTRAZHENII UDARNYKH VOLN OT TORTSA V UDARNOY TRUBE]
T. V. Bazhenova, O. A. Predvoditeleva, and T. V. Nadezhina *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 29–41 refs (See N67-38781 23-12)

The pressures behind the reflected and incident shock waves and the velocities of the reflected shock wave were measured in nitrogen within a range of Mach 4 to 7, with an initial pressure of 12.7 mm Hg. A comparison of the measured values of pressures and velocities with theoretical values shows the presence of losses which decrease the velocities of reflected shock waves by an average of 7% to 10%. Heat fluxes to the wall behind the shock wave were calculated. The results show that time dependences of temperature and thermal flux are not constants. Energy loss is experimentally evaluated by the change in velocity. A numerical example given for a shock wave in nitrogen at M=6.8, initial pressure 0.0167 atm, and reflected wave velocity 870 m/sec shows that the energy losses due to shock wave reflection caused by nonadiabatic processes are one order of magnitude smaller than the total energy losses. Author

N67-38785# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INVESTIGATION OF THE PROCESS OF INTERACTION OF A REFLECTED SHOCK DISCONTINUITY WITH THE BOUNDARY LAYER OF THE FLOW BEHIND AN INCIDENT SHOCK WAVE [ISSLEDOVANIYA PROTESSA VZAIMODEYSTVIYA OTRAZHENNOGO RAZRYVA S POGRANICHNYM SLOYEM POTOKA ZA PADAYUSHCHEY UDARNOY VOLNOY]

S. G. Zaytsev, A. P. Shatilov, Ye. V. Lazareva, and L. N. Trukhanova *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 42–49 refs (See N67-38781 23-12)

The interaction of the front of a reflected shock wave with the boundary layer of an oppositely directed flow, with the aid of an interferometer and high-speed photography, are described. The experiments were carried out at Mach 3–7 and with initial pressures of 10 and 30 mm Hg in commercial nitrogen (about 0.5% oxygen). The speed was measured by photographing a slitted-off part of the interference pattern on a film moving at 0.117 mm/μsec, with an accuracy of 10% for incident and 15% for reflected waves. The density behind the front was also measured and found to be in agreement with calculated values. The interference pattern showed that with Mach numbers up to 6, the perturbation caused by interaction of the reflected shock with the boundary layer of the oppositely directed flow was localized in a certain region adjoining the wall and moving with the reflected shock. After passage of the reflected wave, the gas again became homogeneous. Author

N67-38786# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MEASUREMENT OF DENSITY BEHIND A REFLECTED SHOCK DISCONTINUITY IN NITROGEN [IZMERENIYE PLOTNOSTI ZA OTRAZHENNYM UDARNYM RAZRYVOM V AZOTE]

S. G. Zaytsev, A. P. Shatilov, Ye. V. Lazareva, and L. N. Trukhanova *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 50–60 refs (See N67-38781 23-12)

Using fixed illumination, the change in density with time was determined by an interference method and recorded on film moving at 0.117 mm/μsec, both for the incident and reflected waves. The shocks propagated at Mach 3 to 6; the initial pressures were 10 and 3 mm Hg, the maximum temperature in the reflected shock was 4000°K and dissociation was 0.2%. The equilibrium and non-equilibrium densities for a section 52 mm from the end are graphed for Mach 2.9, 3.8 and 5.6. The time to equilibrium density agrees with that of the oscillatory relaxation found by Blackman. The density behind the reflected shock was also obtained by continuous scanning, at 3 mm from the reflecting end of the tube where interaction with the boundary layer can be neglected. At higher Mach numbers density increases with time; thus the density becomes greater than the calculated value and the divergence increases with time. Author

N67-38787# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

A STUDY OF GAS FLOW IN A SHOCK TUBE USING TOEPPLER'S METHOD AND HIGH-SPEED PHOTOGRAPHY [IZUCHENIYE POTOKOV GAZA V UDARNOY TRUBE PRI POMOSHCHI SKHEMY TEPLERA I SKOROSTNOGO KADROVOGO FOTOGRAFIROVANIYA]

V. P. Ionov, G. N. Nikolayev, M. V. Gusev, and O. I. Luneva *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 62–77 refs (See N67-38781 23-12)

Detailed descriptions of the optical apparatus, shock tube, and the experimental procedure are given. The photographic records used to illustrate the various flow patterns and shock wave reflections in the range from Mach 6.7 to 7.2 are presented and discussed. The method is applied to the study of shock wave reflections from a wall with a slit and also to supersonic flow around obstacles of various shapes in oxygen and nitrogen. The results show the existence of a period of quasi-steady flow which follows the formation of the reflected shock wave and the establishment of the flow. The region behind the reflected shock wave seems to be a reservoir of high-temperature gas acquiring a supersonic velocity by flowing through the slit into the expanding channel. Author

N67-38788# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

MEASUREMENT OF THE VELOCITY OF SHOCK WAVES IN RAREFIED GASES [IZMERENIYE SKOROSTI UDARNYKH VOLN V RAZREZHENNYKH GAZAKH]

G. L. Kabanov *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 78–89 refs (See N67-38781 23-12)

The method of using a counter to measure the time between markers, steadily becoming more widespread since it is fast and accurate, is described. Afterglow is used to render the wave visible and photomultipliers are used as pickups in sets of four at each of two points along the glass shock tube, one at 3.10m and the other at 4.96m from the diaphragm. The input stages include anticoincidence circuits for noise suppression and to distinguish the front of the shock wave. The number of waves from a shock-excited 1 Mc oscillator between the markers is counted by a PS-10000 counter. The circuit diagram and waveforms at various points are illustrated. The markers are used to generate a 10V rectangular pulse using thyratrons, which shock excites a 1 Mc oscillator. The error in time measurement was ±0.8–1 μsec, and the calibration method is described in detail. The systematic error as a function of the time interval is discussed and illustrated. Author

N67-38835*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

TRANSITION FIXING FOR HYPERSONIC FLOW

James R. Sterrett, E. Leon Morrisette, Allen H. Whitehead, Jr., and Raymond M. Hicks (NASA, Ames Res. Center) Washington, NASA, Oct. 1967 21 p refs

(NASA-TN-D-4129) CFSTI: HC $3.00/MF $0.65 CSCL 20D

The overall problems associated with boundary layer trips employed to produce turbulence at hypersonic conditions and related questions are examined. The data indicate that the required roughness heights are so large that whether trips should be used in hypersonic wind tunnel tests depends upon the particular purpose of any experiment. For example, an engineer can successfully use trips to study the heat transfer associated with an aircraft component or to produce turbulent flow in front of an inlet or control that otherwise might be transitional or laminar. However, at the present time, trips cannot be used when an accurate value of the total drag of a configuration is required because of the large pressure drag associated with the roughness elements. With additional study, the drag associated with the roughness elements could probably be determined accurately. The vortex shedding that occurs in the lee side of delta wings at moderate angles of attack places further limitations on the use of trips for wind tunnel simulations of hypersonic cruise vehicles. For any test, care must be taken to dimension the trips properly. Author

N67-38857# General Electric Co., Schenectady, N. Y. Research and Development Center.

CONTINUUM TO FREE MOLECULE FLOW IN THE VICINITY OF THE LEADING EDGE OF A FLAT PLATE AT MACH NUMBERS OF 19.4 AND 24.1

H. T. Nagamatsu, D. C. Wisler, and R. E. Sheer, Jr. Jun. 1967 53 p refs
(Rept.-67-C-247)

The Reynolds number per inch varied from 968 to 19,740 and the leading edge Knudsen number from 0.84 to 26.6. The hypersonic interaction parameter ranged from 26 to 564. At high unit Reynolds number conditions and Knudsen number of order unity, the induced pressure distribution varied as $X^{-1/2}$ and agreed reasonably well with the Li-Nagamatsu theory, including the wall cooling effects. As the unit Reynolds number was decreased with corresponding increase in the Knudsen number, the location of the peak induced pressure moved back from the leading edge and the curves of the induced pressure ratio as a function of the interaction parameter were displaced to the right because of rarefied flow phenomenon. In the strong interaction region for high unit Reynolds number, the shock wave and the boundary layer merged. For unit Reynolds numbers less than 3120 and Knudsen numbers greater than 8.65, the shock wave disappears near the leading edge and reappears downstream in the schlieren photographs. These tests indicate that the rarefied hypersonic flow phenomenon over a flat plate is a function of the leading edge Knudsen number, unit Reynolds number, Mach number, and wall-to-stagnation temperature ratio. Author

N67-38920# General Electric Co., Philadelphia, Pa. Missile and Space Div.
JETS IN FREE VORTEX SURROUNDINGS
A. I. Barcilon Aug. 1967 33 p refs
(R67SD42)

A jet in free-vortex surroundings with known boundary conditions at the base and top is considered. The problem is formulated as a two-point boundary value problem in phase space where the mass flux and its derivative with height are used as independent coordinates. The axial flow is of the boundary layer type over most of the axis. In general, it can only satisfy the two-point boundary conditions by means of discontinuous solutions leading to vortex breakdown formation. The conditions for such a breakdown are analyzed and the breakdown structure is studied. For violent breakdowns, mass and angular momentum are injected into the core at the breakdown region. Author

N67-38948*# Nevada Univ., Reno.
HEISENBERG'S STATISTICAL THEORY OF TURBULENCE AND THE EQUATIONS OF MOTION FOR A TURBULENT FLOW
F. Winterberg Jun. 1967 23 p refs
(Grant NGR-29-001-016)
(NASA-CR-89139) CSCL 20D

Equations of motion for turbulent flow have been derived which are consistent with Heisenberg's statistical theory of turbulence in the sense that Heisenberg's equation for the energy spectrum is an exact consequence of it. In contrast to other phenomenological theories which make some a priori assumption concerning eddy transport coefficients the theory presented in this paper is nonlocal, and as a consequence of the nonlocality the equations are integro-differential equations. The theory is extended to include turbulent convection. The theory may be very useful to determine the character of complicated convection problems in stellar or planetary atmospheres which otherwise can be treated by numerical analysis only under immense computational efforts. Author

N67-39082 Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Munich (West Germany).
TABLES OF UNIVERSAL FUNCTIONS FOR THE CALCULATION OF A CLASS OF LAMINAR BOUNDARY LAYER FLOWS WITH SUCTION AND INJECTION [ZAHLENTAFELN UNIVERSELLER FUNKTIONEN ZUR BERECHUNG EINER KLASSE LAMINARER GRENZSCHICHTSTROEMUNGEN MIT ABSAUGEN UND AUSBLASEN]
H. Goertler and G. Heike Aug. 1967 48 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-51)

For the calculation of steady plane laminar incompressible boundary layer flows with continuous suction or injection, the universal functions up to the fourth order inclusively have been tabulated for bodies with cuspidal leading edge (case $\beta_0=0$) and zero suction velocity at the leading edge (case $\gamma_0=0$). The numerical work involved in applying these tables to flows with arbitrary outer pressure distribution and with suction or injection velocity distributions of a very general class consists only in a few elementary operations. Author

N67-39082# General Electric Co., Philadelphia, Pa. Missile and Space Div.
SOLUTION OF THE THREE-DIMENSIONAL BOUNDARY LAYER EQUATIONS BY A NUMERICAL METHOD
Harry A. Dwyer Aug. 1967 38 p refs
(R67SD54)

A method of calculating accurate solutions of the three-dimensional laminar boundary layer equations has been developed. The method is applied to a problem that exhibits interesting crossflow phenomena, such as flow reversal. The finite difference method can be classified as being essentially implicit, and the stability and convergence properties seem to be very good. Also, the initial value problem posed by the three-dimensional boundary layer equations is discussed, and a method of obtaining initial conditions is obtained. Author

N67-39166# General Dynamics/Pomona, Calif.
MOTION OF A BODY DURING WATER ENTRY. PART I: THEORETICAL HYDRODYNAMIC COEFFICIENTS FOR THE COMPRESSIBLE WATER ENTRY OF A SLENDER CONE
James J. Der Aug. 1967 21 p refs
(ERR-PO-317-1)

The hydrodynamic aspects of a slender cone entering into water with such a high speed that the compressibility effects can no longer be ignored are studied. The forces and pitching moment acting upon a slender cone are determined without an assumption of a specific equation of state. Author

N67-39183 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF TRAJECTORIES AND RANGE OF FANNED AND PAIRED PLANE JETS IN A RESTRICTED CROSS FLOW [O RASCHETE TRAYEKTORIY I DAL'NOBOYNOSTI VEYERNYKH I PARNYKH STRUY V OGRANICHENNOM POPERECHNOM POTOKE]
V. A. Kosterin and Ye. V. Rzhevskiy *In its* News of Inst. of Higher Learning Astron. Eng. 27 Apr. 1967 p 159-170 refs
(See N67-39169 23-32)

The paper presents a theoretical solution of the problem of the form of the center line of fan and twin plane jets in a homogeneous, drifting flow limited by walls. Together with the calculation of the jet form, the question of the range of the jets in a transverse flow is also solved. As a particular case of the general solution, derived for a limited flow, a free flow solution is found. Values of constant coefficient are determined by comparison with experimental data. Author

N67-39215# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
AN ANALYTICAL MODEL FOR THE PREDICTION OF HYDRODYNAMIC INSTABILITY IN PARALLEL HEATED CHANNELS
M. B. Carver Mar. 1967 32 p refs
(AECL-2681) CFSTI: HC $3.00/MF $0.65

The development of an analytical model for use on a digital computer investigating the phenomenon of flow instability in parallel heated channels is presented. Predictions of the threshold of instability given by the model are compared to parallel channel experiments at AECL. Good agreement was found, particularly at high pressures. Author (NSA)

N67-39300# General Electric Co., Philadelphia, Pa. Missile and Space Div.
EQUATIONS OF STATE OF REAL GASES
R. B. Thomas, Jr. Sep. 1967 31 p refs
(R67SD53)

An understanding of the relationship between the basic structure and interactions of atoms and molecules composing a gas is very useful in making precise predictions about its gross thermodynamic properties under given conditions and in providing qualitative estimates of its behavior under conditions where its properties have not actually been calculated. The relationship of the basic quantum mechanical properties of atoms (including ions) and molecules to the macroscopic properties of gases composed of them is developed on the basis of quantum statistical mechanics. The concept of a perfect gas is first discussed in order to provide a framework for discussing the various interactions which occur in real gases, i.e., those having internal degrees of freedom and interactions with neighboring atoms and molecules. Considerable attention is given to the problem of an ionized gas, because of the special nature of the forces between the particles composing it, i.e., long range Coulomb interactions. The influence of level occupation numbers on the thermodynamic properties of a plasma is treated in some detail because of the rather wide application to current problems in technology. Author

N67-39310* Miami Univ., Coral Gables, Fla. Dept. of Mechanical Engineering.
OSCILLATIONS IN TWO-PHASE TWO-COMPONENT FLOW
A. H. Stenning and T. N. Veziroglu Oct. 1964 54 p refs
(Grant NsG-424)
(NASA-CR-59504; Rept.-4) CSCL 20D

Experiments with air–water mixtures have been carried out to determine the boundaries of flow oscillations for several ducting configurations. The problem has also been studied analytically with the aid of an analog computer, and a comparison of the experimental and analytical results is presented. Over a wide range of the variables, the density ratio for instability is predicted within 30%. The frequency of the oscillations is predicted within 7% for the cases where theoretical values are available. Author

N67-39373 Deutsche Forschungsanstalt fur Luft- und Raumfahrt, Brunswick (West Germany).
FLOW EXPERIMENT IN COMBUSTION CHAMBERS WITH AERODYNAMIC FLAME STABILIZATION. PART I: COLD FLOW [STROMUNGSUNTERSUCHUNGEN IN BRENNRAUMEN MIT AERODYNAMISCHER FLAMMHALTUNG. TEIL I: KALTE STROMUNG]
W. Alvermann and R. Ulken May 1967 48 p refs In GERMAN; ENGLISH summary
(DLR-FB-67-36)

The report gives a detailed survey about methods of measuring the flow direction in gases. For a straight and for a swan-neck five-tube probe the calculation principles are presented for determining the value and the direction of the velocity of the fluid. The probes are used for measuring the flow in a rectangular channel in which two jets of compressed air with variable angle are injected from the narrow-sides against the flow. The results presented in direction fields and velocity fields give information about the development of the flow and the possibility of a flame stabilization in regions with low absolute velocity downstream of the secondary jets. Author

13 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; oceanography; cartography; and geodesy. For related information see also: 20 Meteorology; 29 Space Radiation; and 30 Space Sciences.

N67-38072# Princeton Univ., N. J. Dept. of Civil and Geological Engineering.
APPLICATIONS OF THE SOLID AND LIQUID STATE CONCEPTS FOR MACROMERITIC SYSTEMS Final Report, 3 Jan. 1966–2 Feb. 1967
Hans F. Winterkorn 30 Jun. 1967 52 p refs *Its* Res. Ser. No. 9
(Contract AF 19(628)-5805)
(AFCRL-67-0414; AD-657335)

The development of the concept of the liquid and solid states of large-particle (macromeritic) systems is traced briefly, and the consequences with respect to the shear resistance of such systems are pointed out. Subsequently, insights gained by the macromeritic systems theory and practical applications are treated with special reference to: (1) liquefaction of loose natural sand strata by earthquake shock energy, (2) optimization of strength and permeability of granular drainage structures, (3) stabilization of granular soil systems, (4) granular backfill materials for special purposes, (5) Bearing capacity of granular systems, (6) consideration of porosity, internal surface and capillary phenomena in graded granular systems. The report concludes with a synoptic picture of the present state of knowledge on the structure and properties at different bulk densities of a macromeritic monocomponent system of essentially spherical particle shape. Author (TAB)

N67-38095# Philco-Ford Corp., Newport Beach, Calif. Aeronutronic Div.
ABSORPTION BY CO_2 BETWEEN 7125 AND 8000 CM $^{-1}$ (1.25–1.40 MICRONS)
Darrell E. Burch, David A. Gryvnak, and Richard R. Patty 10 Feb. 1967 19 p refs
(Contract Nonr-3560(00); ARPA Order 237)
(U-3930; AD-657116)

Transmission spectra in the 7125-8000/cm region were obtained for CO2 samples with absorber thicknesses as great as 218,000 atm cm(STP). Three absorption bands not observed previously were identified, and the strengths of several bands were determined. Transmission spectra and a table of integrated absorptance versus wavenumber are included for five representative samples. Author (TAB)

N67-38128# Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics.
MEASUREMENT AND INTERPRETATION OF MOTIONAL ELECTRIC FIELDS IN THE SEA
Thomas Bayes Sanford (Ph.D. Thesis) Jun. 1967 162 p refs
(Contract Nonr-1841(74))
(AD-655891)

The total motional electric current distribution is investigated for a quasi-steady, 3-dimensional ocean current. In order that electric currents associated with time variations in the induced magnetic field be negligible, a restriction is placed on the temporal and spacial variations of the flow. The quasi-static electric potential is calculated for a general flow and for a model of the Gulf Stream. The 3-dimensional solution for the electric potential is particularized for a 2-dimensional current which is broad compared with the oceans depth. It is shown that for such a broad flow the electric current stream function is proportional to a transport function. The surface expression and total structure of the electric current are calculated for several simple flows and for a cross section of the Gulf Stream. A detailed comparison of several GEK traverses across the Gulf Stream taken in conjunction with hydrographic sections reveals the presence of inertial period oscillations in the surface layers. TAB

N67-38144# Weapons Research Establishment, Salisbury (Australia).
TEMPERATURE CORRECTIONS TO A BEAD THERMISTOR IN THE UPPER ATMOSPHERE
A. D. Hind May 1966 28 p refs
(PAD-121)

An investigation has been made into the temperature corrections to be applied to a bead thermistor which is used to measure temperature in the 200,000 ft to 100,000 ft region of the atmosphere. The corrections applied to a temperature profile obtained from a Dropsonde firing at Woomera on 22nd March 1966 are shown in detail. Author

N67-38145*# Geological Survey, Washington, D. C.
A PHOTO-MOSAIC OF WESTERN PERU FROM GEMINI PHOTOGRAPHY
Jules A. MacKallor Oct. 1967 16 p refs
(NASA Order R-09-020-013)
(NASA-CR-89072; NASA-87) CFSTI: HC $3.00/MF $0.65 CSCL 08B

Photographs taken during the Gemini IX mission are arranged in a 1:1,000,000-scale photo-mosaic extending from the Sechura Desert in northern Peru to northern Chile and from the Pacific Ocean to the headwaters of the Amazon. In addition to geological features, such things as landslides, roads, snow fields, irrigated lands, jungle agricultural sites, archeological sites, and smoke (brush burning) have been identified. A lineation, interpreted here as a major fault, extends across several photographs and for several hundred miles. The magnitude of this lineation was not realized until the photographs were rectified and the mosaic constructed. For many purposes this mosaic is superior to the best existing 1:1,000,000-scale conventional maps of the area. This mosaic will supplement existing conventional maps and aerial photographs. Author

N67-38147# Agricultural Research Service, Ithaca, N. Y. Soil and Water Conservation Research Div.
THE ENERGY BUDGET AT THE EARTH'S SURFACE: PRELIMINARY WIND TUNNEL STUDIES OF PHOTOSYNTHESIS AND TRANSPIRATION OF FORAGE STANDS Interim Report
L. A. Hunt, I. I. Impens, and E. R. Lemon Dec. 1966 27 p refs Prepared in Cooperation with Cornell Univ.
(Order CSO-2-66)
(ECOM-2-66I-2; RR-390; AD-655910)

Vegetative stands of alfalfa and orchardgrass, grown in flats in a glasshouse, were investigated in a small wind tunnel. The windspeed parameters of the crop surfaces were determined at low radiation intensity at each of two windspeeds; and the rates of net photosynthesis and evapotranspiration were measured at the two windspeeds at each of three radiation intensities. The roughness length (zo) increased with windspeed and was greater in orchardgrass. Rate of net photosynthesis, but not evapotranspiration, also increased with windspeed. In consequence, water-use was most efficient under the highest wind regime. The rate of net photosynthesis increased to the intermediate radiation intensity, whereas evapotranspiration increased and water-use efficiency decreased to the highest radiation regime. The work indicated that a small wind tunnel of the type described would be useful for further studies of the photosynthesis and transpiration of forage stands. Author (TAB)

N67-38148# Kansas Univ., Lawrence. Dept. of Geography.
VERTICAL EXAGGERATION IN THREE-DIMENSIONAL MAPPING
George F. Jenks and Fred C. Caspall Jul. 1967 34 p refs
(Contract Nonr-583(15))
(TR-2; AD-657441)

The experiments reported upon indicate that 3-D maps can and should be made with vertical exaggeration. The approximate amount of vertical exaggeration needed to create realistic maps has been found to correlate with the contour interval of the base map. It has also been shown that skilled map-readers can consistently evaluate 3-D maps. The report contains all of the data collected in the experiments and includes a large number of illustrations of 3-D maps. The vertical exaggerations to be used in different mapping situations are presented in graphic form. Author (TAB)

N67-38153# Weapons Research Establishment, Salisbury (Australia).
CHEMICAL SEEDING OF THE UPPER ATMOSPHERE—CHEMILUMINESCENCE OF NITROGEN DIOXIDE AT 110KM ALTITUDE
C. L. Cook, L. J. Drummond, and L. M. Sheppard Oct. 1966 18 p refs
(CPD-116)

A chemiluminescent cloud was formed at 110 km altitude following the release of 4.5 kg of gaseous nitrogen dioxide at evening twilight. A shock wave, expanding around the cloud, was observed on the photographs taken at different intervals and the speed of sound in the medium at 110 km was calculated as 380 $msec^{-1}$, corresponding to a temperature of 340°K. The concentrations of atomic oxygen and atomic nitrogen have been calculated from the radiance profiles and the radiant power results and are found to be 10^{12} and 10^{10} atom cm^{-3} respectively. The rate constant of the light emitting reaction between nitric oxide and atomic oxygen has been deduced as 2×10^{-14} cm^3 sec^{-1}. Possible reaction mechanisms are discussed. Finally, an outline of future investigations is presented. Author

N67-38178# California Univ., Berkeley. Hydraulic Engineering Lab.
METHODS FOR THE ANALYSIS OF NON-STATIONARY TIME SERIES WITH APPLICATIONS TO OCEANOGRAPHY
Lloyd John Brown May 1967 140 p refs
(Contract DACW72-67-C-0002)
(HEL-16-3; AD-655256)

The probability structure for a type of real, mean zero, second order non-stationary stochastic process is shown to depend upon a non-stationary spectral density rho(lambda, tau) (if it exists). This dissertation treats the problem of estimating rho(lambda, tau) from a finite part of a sample function of the process. Two methods are developed: the case where rho(lambda, tau) is locally slowly varying, and the case where rho(lambda, tau) is linearly seperable. The statistical properties of these methods are investigated and approximations to the sampling distribution of the estimators are obtained for the Gaussian case. Spectral representations for the estimates and their variances are obtained. A non-stationary version of the pseudo-integral representation investigated by Tukey and used by Pierson is shown to be rigorously definable and to correspond to a strongly normal non-stationary process of the type considered above. Several examples of the use of the methods are shown. In particular, the time varying spectral density of the Crescent City tsunami of May 23, 1960 is estimated. Author (TAB)

N67-38183# Columbia Univ., Palisades, N. Y. Lamont Geological Observatory.
OPERATION OF A LONG PERIOD SEISMOGRAPH NETWORK UTILIZING MAGNETIC TAPE RECORDING AND ANALYSIS OF DATA RECORDED ON MAGNETIC TAPE Final Report, Jun. 1965–May 1967
Paul W. Pomeroy 1 Jul. 1967 23 p refs
(Contract AF 19(628)-5058; ARPA Order 292; Proj. Vela-Uniform)
(AFCRL-67-0449; AD-657320)

The worldwide network of long-period seismographs recording on magnetic tape established under the sponsorship of AF19(604)-8485 has been operated continuously under the present contract. The stations at Mt. Tsukuba, Japan; Honolulu, Hawaii; Uppsala, Sweden; Huancayo, Peru; College, Alaska; Canberra, Australia; and Palisades, New York, have produced large amounts of valuable data. Many studies utilizing this data have been carried out and several of these are of particular significance to the VELA-UNIFORM program. These include: the relative excitation of surface and body waves by the underground nuclear explosion Long Shot, the magnitude and AR measurements from nuclear explosions and earthquakes in the Western United States, the determination of energy radiation patterns for GNOME, HARDHAT, and the New Madrid and Hebgen Lake earthquakes, the amplitude frequency content and travel times of PcP from nuclear explosions and earthquakes. These studies together with many others utilized the data from this network and indicate the value of this type of recording. Author (TAB)

N67-38224*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE VARIABILITY OF IONOSPHERIC PARAMETERS
N. P. Ben'kova and A. N. Sukhodol'skaya *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 232–236 refs (See N67-38201 23-29)

The diurnal and seasonal variations of the hourly values of the F_2 layer parameters, and their standard deviation and asymmetry are discussed. The data are given in graph and table form. It is considered that the data indicate that the standard deviation of the hourly values is largely determined by regular seasonal variation and that the nighttime values of f_0F_2 characterize the ionospheric disturbances. N.E.N.

N67-38226*# Israel Program for Scientific Translations, Ltd., Jerusalem.
A STUDY OF TEMPERATURE FLUCTUATIONS OF THE UPPER ATMOSPHERE, ACCORDING TO DATA OF UNDERGROUND COSMIC-RAY MEASUREMENTS
A. I. Kuz'min, P. A. Krivoshapkin, G. F. Krymskii, and G. V. Skripin *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 246–253 refs (See N67-38201 23-29)

Results concerning the periodic temperature fluctuations in the mesosphere are presented, based on continuous recordings in 1959–1960 of the cosmic ray intensity, for zenith angles of 30° and 60°, at ground level and at 20 and 60 m.w.e. underground. Details are discussed of the seasonal, diurnal, and 27-day variations. Graphs are included of the cosmic ray and muon intensities and of the temperature coefficients. The explanation of the hard component generation as being due to intermediate nuclear-active mesons is felt to be verified. It is also noted that the temperature oscillations show a good fit with data obtained from spectral observations of the luminous emission of the night sky. N.E.N.

N67-38247# Finnish Meteorological Office, Helsinki.
SOME DYNAMIC APPLICATIONS OF UPPER-WIND STATISTICS
E. O. Holopainen 1966 19 p refs
(Rept.-62) CFSTI: HC $3.00/MF $0.65

Annual averages, variances, and covariances of the zonal and meridional wind components over the Northern Hemisphere have been computed from the seasonal wind statistics data. These annual statistics have been applied to the equation of zonal motion to deduce an estimate of the mean meridional circulation and to evaluate the mean zonal stress between the atmosphere and the earth. The statistics have been applied also to the equation of meridional motion to determine the degree of geostrophic balance of the mean zonal circulation. Author

N67-38278# European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
ENVIRONMENTAL RADIOACTIVITY: ISPRA 1966
M. de Bortoli, P. Gaglione, and A. Malvicini Aug. 1967 71 p refs
(EUR-3554.e) CFSTI: HC $3.00/MF $0.65

Briefly described are the measurements of environmental radioactivity performed during 1966 by the site survey group of the Protection Service. Data are given on the concentrations of strontium 90, cesium 137 and other radionuclides in fallout, air, soil, waters, herbage, animal bones and foods. Author

N67-38291 National Physical Lab., New Delhi (India).
IONOSPHERIC DATA
Jun. 1966 95 p
(RRC-A133)

Hourly values of the ionospheric characteristics are tabulated. The participating stations are Delhi, Ahmedabad, Haringhata (Calcutta), Bombay, Hyderabad, Madras, Tiruchirapalli, Kodaikanal, and Thumba (Trivandrum). Geographic and geomagnetic data, and equipment details for each station is included. N.E.N.

N67-38292 National Physical Lab., New Delhi (India).
IONOSPHERIC DATA
Jul. 1966 74 p For abstract see N67-38291.
(RRC-A134)

N67-38298*# Ohio State Univ. Research Foundation, Columbus.
PREPROCESSING OPTICAL SATELLITE OBSERVATIONS
Frank Donald Hotter Apr. 1967 188 p refs *Its* Rept. of the Dept. of Geodetic Sci.
(Contract NSR-36-008-033; OSURF Proj. 1997)
(NASA-CR-86081; Rept.-82) CFSTI: HC $3.00/MF $0.65 CSCL 08E

The purpose of the report is to examine the basic theory of stellar triangulation; review the procedures that four U.S. agencies currently use in reducing geodetic satellite observations for the National Geodetic Satellite Program; recommend preprocessing procedures to homogenize the data from the agencies for further geodetic studies; and finally recommend that additional data as specified in the report be provided for the National Aeronautics and Space Administration so that the data from various agencies may be correlated. Author

N67-38303 National Physical Lab., New Delhi (India).
SOLAR AND GEOPHYSICAL DATA, PART 2
Apr. 1967 16 p
(RRC-A142, Pt. 2)

Tabulated data are presented on predicted and observed sunspot numbers, solar fluxes and flares, magnetic storms, and ionospheric effects of solar flares. Geographic and magnetic details are included for the participating stations of Kodaikanal, Delhi, Haringhata, and Ahmedabad. N.E.N.

N67-38304 National Physical Lab., New Delhi (India).
SOLAR AND GEOPHYSICAL DATA, PART 2
May 1967 18 p For abstract see N67-38303.
(RRC-A143, Pt. 2)

N67-38305 National Physical Lab., New Delhi (India).
SOLAR AND GEOPHYSICAL DATA, PART 2
Jun. 1967 14 p For abstract see N67-38303.
(RRC-A144, Pt. 2)

N67-38322# Washington Univ., Seattle. Atmospheric Sciences Dept.
MEASUREMENTS OF THE CHEMICAL CONSTITUTION OF THE ATMOSPHERE AT THE BLUE GLACIER FIELD STATION, MT. OLYMPUS, WASHINGTON SUMMER 1966
J. J. Kelley, Jr. and S. M. Hodge Jul. 1967 52 p refs
(Contract Nonr-477(24))
(SR-1; AD-657446)

The results of the measurements on Mt. Olympus, Washington, of carbon dioxide, oxidant, water vapor, particulate matter, and total gamma-ray emitters in the atmosphere are presented, and analytical methods are described. Average daily concentrations are tabulated. Diurnal variations are given for total oxidant, water vapor, and carbon dioxide. Author (TAB)

N67-38337# European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center.
SOME GEOLOGIC CONCEPTS AS A GUIDE FOR THE SEARCH OF URANIUM IN THE PRECAMBRIAN SHIELDS
L. Van Wambeke Jun. 1967 62 p refs
(EUR-3481-e)

The distribution pattern of the uranium occurrences in the Precambrian shields can be explained mainly on the basis of the geological and paleogeographical evolution of sedimentary basins which are either intracratonic or geosynclinal. In intracratonic basins, uranium occurs either in sediments, in acid/intermediate volcanics or in veins and is essentially located in the marginal zones of the basins and in the neighbouring basement. Favourable areas for uranium are mainly confined to these marginal zones of sedimentation and attention must be focused especially on intracratonic basins either containing interbedded acid/intermediate volcanics in the stratigraphic series or formed by intense fracturing of the basement. In geosynclines, the distribution of uranium occurrences is more complicated because these basins have been affected during the orogenies by magmatichydrothermal activity and metamorphism. However, a relationship also seems to exist between the location of uranium deposits and marginal zones of sedimentation. This feature is not only valid for uranium mineralizations in sediments but may explain uranium occurrences such as veins and pyrometasomatic deposits. The distribution of uranium occurrences related to post-Caledonian events in the shields' areas is also discussed. Geological criteria which may be used for a preliminary evaluation of the uranium outlook in the Precambrian belts are described. Examples of poorly or unprospected areas apparently favourable for uranium are given. Application of geologic concepts is an important step for the choice of the most promising areas to be prospected for uranium. Author

N67-38387*# Alaska Univ., College. Geophysical Inst.
INVESTIGATION OF AURORAL ZONE IONOSPHERIC FORWARD SCATTER Final Report, 1 Apr. 1965–31 Dec. 1966
Glenn M. Stanley 31 Dec. 1966 20 p refs
(Contract NSR-02-001-020)
(NASA-CR-89077) CSCL 04A

Installation and operation of a field site at Allakatet, Alaska are described. The site was operated between September 1965 and March 1966 to obtain and analyze data relating to the large enhancements which appear on signals propagated by ionospheric forward scatter. Allakatet is in the vicinity of the midpoint of an auroral zone ionospheric forward scatter circuit between Point Barrow and Anchorage. The site was equipped with an ionosonde, two all-sky cameras, a 30 MHz riometer, and a magnetometer. The quality of the data collected is considered good. Analysis of the data has not been completed. A short paper derived from the data is presented. The paper considers quantitative aspects of the precipitation of relativistic and less energetic electrons in and near the auroral zone. E.C.

N67-38413 Finnish Meteorological Office, Helsinki.
MONTHLY AND YEARLY MEAN VALUES OF GEOMAGNETIC ELEMENTS AND GEOMAGNETIC ACTIVITY INDICES K AND C FROM NURMIJAERVI GEOPHYSICAL OBSERVATORY, 1953–1965
C. Sucksdorff, V. A. Helminen, and M. Kivinen 1966 55 p refs *Its* No. 7

The tabulated mean values were calculated from hourly values recorded on magnetic tape. The methods of measuring, checking, and processing are outlined. N.E.N.

N67-38415 Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE NUMBER 164
19 Sep. 1967 145 p refs Transl. into ENGLISH from Russian Publ.
(JPRS-42674; TT-61-11147-164) CFSTI: $3.00

A semimonthly compilation is presented of Soviet published writings on a wide variety of topics in the fields of astronomy, meteorology, oceanography, terrestrial geophysics, and upper atmosphere and space research. Individual items are either in abstract or summary form with a limited amount of full translations. Complete bibliographic information is included. E.C.

N67-38420# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.

A PROGRAM FOR COMPUTING HIGH ENERGY ELECTROMAGNETIC CASCADES IN EXTENSIVE AIR SHOWERS [EIN PROGRAMM ZUR BERECHNUNG ENERGIEREICHER ELEKTROMAGNETISCHER KASKADEN IN LUFTSCHAUERN]

K. E. Schlegel Apr. 1967 25 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-30)

A program for the calculation of high-energy electromagnetic cascades in extensive air showers is described. This Fortran Program is based on the theory of electromagnetic cascades by Nishimura and Kamata. Another Fortran Program FTLS for the calculation of high energy nuclear active particles in extensive air showers is used. Special consideration is given to the calculation of electromagnetic subcores, which may be detected by neonhodoscope pictures. Preliminary results are presented. Author (NSA)

N67-38434# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

SHORT-PERIOD OSCILLATIONS IN THE EARTH'S ELECTROMAGNETIC FIELD

P. A. Vinogradov 6 Jun. 1967 25 p refs Transl. into ENGLISH from Geomagnetizm i Aeronomiya (Moscow), 1966 p 256–267
(Contract NOw-62-0604-c)
(TG-230-T524; TT-67-62663; AD-657164)

Short-period oscillations of the earths electromagnetic field with periods of 1-500 sec are of two basic types: regular, almost-sinusoidal oscillations of a persistent nature, and irregular, erratic oscillations. Some regularities are estsblished for changes in the period spectrum of these oscillations as a function of storm intensity. Short-period oscillations connected with bremsstrahlung from energetic electrons incident in the upper atmosphere are described. The mean regularity of excitation of the small-period oscillations is compared with regularities in the occurrence of luminous atmospherics. It is found that (in the case of similar diurnal, annual and cyclic variations) small-period oscillations and F-scattering appeared simultaneously in only 40-50% of the cases at the middle latitudes. TAB

N67-38567# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.

THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL. PART I: CONSTRUCTION AND PRELIMINARY RESULTS [DAS KIELER LUFTSCHAUEREXPERIMENT. TEIL I. UEBERBLICK UEBER AUFBAU UND VORLAEUFIGE MESSERGEBNISSE]

E. Boehm, W. D. Buescher, R. Fritze, F. Kassner, H. G. Priesmeyer et al May 1967 44 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-38)

The physical background, the construction, and principal goals as well as preliminary results of the air shower experiment are reviewed. Author (NSA)

N67-38588# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.

THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL. PART II: DIGITAL RECORDING OF SCINTILLATION COUNTER PULSES [DAS KIELER LUFTSCHAUER-EXPERIMENT. TEIL II. DIGITALISIERUNG DER SZINTILLATIONS-ZAEHLERAMPLITUDEN]

R. Staubert May 1967 46 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-39)

A general survey about the logic of the recording system and the electronics of the air shower experiment at Kiel is given. The measurement of particle numbers is described in detail. The scintillation counter amplitudes are digitized using a logarithmic analog-to-digital converter with a dynamics of $1:10^4$. Author (NSA)

N67-38675# Avco Corp., Wilmington, Mass. Missile, Space and Electronics Group.

ANTARCTIC RESEARCH AND DATA ANALYSIS. THE NATURE OF SPREAD-F IRREGULARITIES IN ANTARCTICA

Gordon G. Bowman 21 Dec. 1966 61 p refs
(Contract NSF C-403)
(AVSSD-0322-66-CR; SR-25)

Some characteristics of spread-F ionograms from the Antarctic region are discussed. Very disturbed periods, such as when magnetic storms are in progress, have been neglected in this analysis. Two important characteristics are the frequent occurrence of resolved as well as diffuse traces, and the appearance from time to time of an enhanced trace which seems to arrive from directions close to the magnetic-field direction. Two independent sets of spread-F traces are reported. Several possible models are examined and some ray tracing performed. The analysis favors a model which incorporates kinking of the contours of equal ionization density to produce "wavelengths" in the ionospheric structure of some tens of kilometers. Because of the similarities at mid- and high-latitude regions, it is suggested that similar mechanisms are operating at both regions to produce spread F. Author

N67-38707*# Volt Technical Corp., Washington, D. C.

THE SPECTRAL COMPOSITION OF THE EARTH'S INFRARED RADIATION INTO SPACE ACCORDING TO THE MEASUREMENT RESULTS FROM EARTH'S ARTIFICIAL SATELLITES

A. I. Lebedinskiy, Yu. G. Andranov, and G. N. Barkova 4 Oct. 1967 14 p refs Transl. into ENGLISH of the Russian Paper Presented at the X COSPAR Assembly, London, Jul. 1967
(Contract NASS-12487)
(NASA-CR-88969; ST-AM-SPC-10649) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The spectra of outgoing radiation were measured in the 7 to 38μ range using satellite-borne monochromators. Up to 10,000 spectra were thus obtained. It took 20 seconds to obtain each spectrum, the resolution on the ground being 10 km. The measured spectra were selectively compared with those computed from aerological sounding data. The spectra selected were obtained at meteorological stations at times close to those of the aerological soundings. The near-ground temperatures were selectively compared with temperatures for various wavelengths measured from the satellite in cloudless regions. The connection of spatial distribution of radiation temperatures for various wavelengths with the distribution of cloudiness along orbits was analyzed. A statistical processing of 1278 spectrograms was made for the earth as a whole without breaking them up into latitude ranges. The unidimensional differential laws of distribution of the outgoing radiation were approximated using Pearson's curves. Correlation factors for the spectral intensity of the outgoing radiation in various spectral ranges were determined on the basis of the analysis of the two-dimensional differential laws of distribution. Author

N67-38709# Douglas Aircraft Co., Inc., Santa Monica, Calif. Missile and Space Systems Div.

PASSIVE MICROWAVE RADIOMETRY OF SEA STATE

V. A. Sirounian Sep. 1967 34 p refs
(DAC-60786)

The problem of reflection and emission of microwave radiation from a rough sea is examined. The study is conducted by means

of a statistical distribution. Reflection matrices for two sets of Stokes polarization parameters are determined. Using the theory of reciprocity, expressions are obtained for the polarized emissivity of rough sea. The resulting analytical solutions are programmed for an IBM 7094 computer. The numerical results obtained show the following: (a) changes of polarized brightness temperature vary with ocean roughness and are of measurable magnitude (i.e., about 7°K change for a 5 msec change of wind velocity at an observation angle of 60°); (b) changes of the perpendicular component of brightness temperature are stronger in terms of ocean roughness than the parallel component; (c) changes in polarized components of brightness temperature are greatest at angles of observation of 50° to 70°; (d) the polarization magnitude of the emitted microwave radiation increases slightly at small angles of observation and decreases at large angles of observation, depending on ocean roughness; and (e) changes of the magnitude of polarization resulting from ocean roughness are pronounced at 50° to 70° angles of observation. Author

N67-38713*# Southwest Center for Advanced Studies, Dallas, Tex.

MONTE CARLO CALCULATIONS OF LIGHT SCATTERING FROM CLOUDS

Gilbert N. Plass and George W. Kattawar 23 May 1967 46 p refs Sponsored in part by NASA

(Contract AF 19(628)-5039)

NASA-CR-89263; AFCRL-67-0421; SR-2; AD-657363) CSCL 04A

The scattering of visible light by clouds is calculated from an efficient Monte Carlo code which follows the multiply scattered path of the photon. The single scattering phase function is obtained from the Mie theory by integration over a particle size distribution. The photons are followed through a sufficient number of collisions and reflections from the lower surface (which may have any desired albedo) until they make a negligible contribution to the intensity. Various variance reduction techniques were used to improve the statistics. The reflected and transmitted intensity is studied as a function of solar zenith angle, optical thickness, and surface albedo. The downward flux, cloud albedo, and mean optical path of the transmitted and reflected photons are given as a function of these same parameters. The numerous small angle scatterings of the photon in the direction of the incident beam are followed accurately and produce a greater penetration into the cloud than is obtained with a more isotropic and less realistic phase function. Author (TAB)

N67-38717*# Pennsylvania State Univ., University Park. Ionosphere Research Lab.

PRESUNRISE EFFECTS DUE TO CONJUGATE REGION PHOTOELECTRONS

M. W. Kwei 1 Aug. 1967 102 p refs

(Grant NSG-134-61)

(NASA-CR-89273; SR-301) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Photoelectron fluxes have been used to examine the mechanism of pre-sunrise heating at Arecibo. Detailed analyses are made of the escaping photoelectron flux from the conjugate region including the effect of elastic collisions with neutrals in confining the photoelectrons. Comparisons between the theoretical heat input and observed energy losses in ambient electrons are presented. Also the theoretical and measured heat fluxes are compared. Calculations have been made of the enhancement in intensity of the 6300 Å airglow and these results are compared with measurement at Haute Provence. In this way a comparison has been made which shows that the direct excitation of the airglow by the photoelectrons predominates over excitation by the heated ambient electrons. Author

N67-38722# Martin Co., Baltimore, Md.

GEOPHYSICAL CONSTANT DETERMINATION FROM SATELLITE OBSERVATIONS: DIGITAL COMPUTER PROGRAM Final Report, May 1966–Jun. 1967

Karlis Minka, Bruce E. Clemenz, and Jacques Fein Jun. 1967 132 p refs

(Contract AF 19(628)-4167)

(ER-14617, Vol. I; AFCRL-67-0426, Vol. I; AD-657361)

The computer program is based on a development of the Minimum Variance Method contained in Report AFCRL-66-579 (Martin Marietta Report ER 13950, Ref. 1). The partial derivatives of the rectangular coordinates with respect to the classical elements, which are not covered in Ref. 1, are given in the appendix. A general description of the program including discussion of the inputs, operating modes, initial value estimation and a test sample is presented. Also included are the program inputs and outputs, lists of symbols, flow charts and other essentials necessary to operate the program and to facilitate any subsequent modifications. The program is written in FORTRAN IV and machine language (MAP). The major part of the program is in double precision. Author (TAB)

N67-38789*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.

THE RADIATION BALANCE OF THE EARTH–ATMOSPHERE SYSTEM OVER BOTH POLAR REGIONS OBTAINED FROM RADIATION MEASUREMENTS OF THE NIMBUS II METEOROLOGICAL SATELLITE

Ehrhard Raschke, Fritz Moeller (Munich Univ.), and William R. Bandeen Sep. 1967 31 p refs

(NASA-TM-X-55954; X-622-67-460) CSCL 04A

Measurements of the outgoing emitted longwave radiation and the reflected solar radiation were obtained during the period 16 May–28 July, 1966 and covered the onset and development of the summer and winter seasons in the Northern and Southern Hemispheres, respectively. The results of the outgoing longwave radiation, the albedo, and the radiation balance of the earth–atmosphere system were obtained as averages for five subperiods, each of a half month's length. The albedo over the Central Arctic north of 80°N diminished continuously from May to the end of July from 68% to 50% due to the melting of ice and snow surfaces. The radiation balance only during the first half of July became slightly positive (+0.012 cal cm^{-2} min^{-1}) there. During all other subperiods, it resulted in a net radiation flux toward space. Over the Antarctic during this season the radiation balance is almost entirely determined by the outgoing longwave radiation flux. The global albedo for all five subperiods was found to be about 30%. This value is considerably less than earlier accepted values. The radiation balance over the entire globe resulted in a slight energy gain during the second half of May and a deficit during the other four subperiods. Author

N67-38928# Japan Atomic Energy Research Inst., Tokyo.

A STUDY ON NATURAL GAMMA RAY LOG

Shun-ichi Seno Jun. 1967 18 p refs Submitted for publication

(NSJ-Tr-84) CFSTI: HC $3.00/MF $0.65

This report represents an overall review of research on natural gamma ray logging. The errors of the estimated thickness of formation or the estimated boundary of formations are theoretically discussed, based on some simplified assumptions, especially in relation to effective length of detector. Characteristics of actual detectors and electronic circuits are also described. Applications to uraniferous ore deposit, Kuroko type metallic ore deposit, and coal field are briefly summarized. Author

N67-38934# Avco Corp., Wilmington, Mass. Space Systems Div.

ANTARCTIC RESEARCH AND DATA ANALYSIS: EXTREMELY LARGE TRAVELING IONOSPHERIC DISTURBANCES IN ANTARCTICA

Gordon G. Bowman 10 Jan. 1967 60 p refs

(Contract NSF C-403)

(AVSSD-0354-66-CR; SR-26)

Direction-of-arrival information is available on ionograms from Ellsworth, Antarctica because of inteference effects from the Filchner Ice Shelf. This has allowed the detection of extremely large traveling ionospheric disturbances which appear to move towards the equator in the vicinity of the auroral zone, in the hours before local midnight. These disturbances produce troughs in the bottomside ionosphere as wide as 1000 km. In the troughs the f_0F_2 values fall by factors which vary between 3 and 7 for the cases investigated. Disturbance effects are also recorded in the D and E layers. Associations with radio and optical auroras and magnetic activity were found which suggest that these disturbances are intimately related to auroral-zone activity. Speeds of the order of 100 m/sec are found. It is suggested that the disturbances result from the propagation of internal gravity waves generated at magnetic noon at a magnetic latitude of about 80°. Author

N67-38938*# Southwest Center for Advanced Studies, Dallas, Tex.

CALCULATIONS OF REFLECTED AND TRANSMITTED RADIANCE FOR EARTH'S ATMOSPHERE

Gilbert N. Plass and George W. Kattawar 13 Sep. 1967 28 p refs Submitted for publication

(Grant NsG-269; Contract AF 19(628)-5039)

(NASA-CR-89276; SR-6) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The reflected and transmitted radiance of the earth's atmosphere is calculated by Monte Carlo techniques. The exact scattering function for the aerosols is used as calculated from the Mie theory. The aerosol vs. height distributions are compared. The Rayleigh and aerosol scattering events are included in the calculation, as well as the ozone absorption, where appropriate. Results are given at wavelengths of 0.27, 0.3, 0.4, 0.7, and 1.67μ. The mean optical paths of the reflected and transmitted photons, the flux at the lower boundary, and the planetary albedo are tabulated. Author

N67-38988# Naval Air Development Center, Johnsville, Pa. Sonar Processing Div.

VELOCITY PROFILE ATLAS OF THE NORTH ATLANTIC. VOLUME I: 20° TO 40°N

D. W. Mackiernan 1 Dec. 1966 514 p

(NADC-AE-6647, Vol. I; AD-650135) CFSTI: HC $3.00/MF $0.65

The velocity profiles in this Atlas were obtained from historical data supplied by the National Oceanographic Data Center (NODC). The profiles are derived from Nansen cast data with the velocity computed from Wilson's equations. The format is based on a one degree month and seasonal analysis and generally covers the North Atlantic area bounded by the coordinates 20 degrees N to 60 degrees N and 30 degrees W to 90 degrees W. In order to reduce the bulkiness of the Atlas, a latitudinal division was decided upon with Volume I covering the area between 40 degrees N to 60 degrees N and Volume II the area from 20 degrees N to 40 degrees N. Author (TAB)

N67-38989# Naval Air Development Center, Johnsville, Pa. Sonar Processing Div.

VELOCITY PROFILE ATLAS OF THE NORTH ATLANTIC. VOLUME II: 20° TO 40°N

D. W. Mackiernan 1 Dec. 1966 326 p

(NADC-AE-6647, Vol. II; AD-650136) CFSTI: HC $3.00/MF $0.65

The velocity profiles in this Atlas were obtained from historical data supplied by the National Oceanographic Data Center (NODC). The profiles are derived from Nansen cast data with the velocity computed from Wilson's equations. The format is based on a one degree month and seasonal analysis and generally covers the North Atlantic area bounded by the coordinates 20 degrees N to 60 degrees N and 30 degrees W to 90 degrees W. In order to reduce the bulkiness of the Atlas, a latitudinal division was decided upon with Volume I covering the area between 40 degrees N to 60 degrees N and Volume II the area from 20 degrees N to 40 degrees N. Author (TAB)

N67-39063* Pittsburgh Univ., Pa. Space Research Coordination Center.

NIGHTGLOW SPECTRAL LINE SHAPES OF OXYGEN λ6300 AND λ5577 RADIATION

Manfred A. Biondi and Walter A. Feibelman Sep. 1967 31 p refs

(Grant NsG-416; Contract Nonr-624(13); Grant NSF GP-4435)

(NASA-CR-89317; SRCC-56) CSCL 04A

A pressure-tuned Fabry–Perot interferometer employing photoelectric detection was used to measure the oxygen λ6300 and λ5577 spectral line profiles during twilight and the night at the Airglow Observatory on Laurel Mountain, Pennsylvania. The inferred O(^{1}D) atom temperatures, ranging from ≈600–1600°K, are compared with the predicted temperature variations using empirical models relating solar activity to exospheric heating, and agreement is found on some nights, while substantial discrepancies (≈400°K) are found on others. No evidence for a diasociative origin of the ^{1}D or ^{1}S oxygen atoms has been detected in the line profiles obtained to date; however, there is a possible indication of F-layer wind velocities of ≈400 m/s. Author

N67-39065*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

INTERACTION BETWEEN UPPER AND LOWER ATMOSPHERE

W. Nordberg Sep. 1967 34 p refs Presented at the IQSY Symp. London, 17 Jul. 1967

(NASA-TM-X-55951; X-620-67-458) CFSTI: HC $3.00/MF $0.65 CSCL 04A

A multitude of rocket observations were conducted during IQSY which, for the first time, established a synoptic picture of the entire stratosphere, at least in selected regions of the globe, and gave an insight into the seasonal and large scale zonal and meridional behavior of the mesosphere. These massive rocket observations were supplemented by observations from the ground (sodium glow) from satellites (temperature patterns in the stratosphere) and by a number of fundamental theoretical investigations (e.g., treatment of radiative equilibrium, large scale horizontal eddies, gravity waves, tidal oscillations, etc.). Results from these observations and analyses produced some sketchy, though important, inferences of interactions especially between the lower stratosphere and the upper mesosphere. But, perhaps more importantly, they established an understanding of the physics and dynamics of the "middle atmosphere". In the future this understanding will permit the tracing of interactions through this region and across its lower and upper boundaries and will perhaps lead to the delineation of cause and effect of these interactions. Author

N67-39073*# Southwest Center for Advanced Studies, Dallas, Tex.

INFLUENCE OF SINGLE SCATTERING ALBEDO ON REFLECTED AND TRANSMITTED LIGHT FROM CLOUDS

Gilbert N. Plass and George W. Kattawar 12 Jul. 1967 30 p refs Sponsored in Part by NASA
(Contract AF 19(628)-5039)
(NASA-CR-89337; AFCRL-67-0450; SR-4) CFSTI: HC $3.00/MF $0.65 CSCL 04A

The dependence of the reflected and transmitted light from clouds on the single scattering albedo ω_0 is studied. The multiply scattered path of the photon in the cloud is accurately simulated by Monte Carlo techniques. When the cloud is thin and the surface albedo A=0, the reflected and transmitted radiances vary nearly as ω_0 for fixed angles of incidence and observation and they depend strongly on the value of A. As ω_0 becomes small and for thick clouds, the reflected radiance approaches more closely the value calculated from the single scattering phase function. As the absorption increases the transmitted radiance at the zenith becomes larger relative to the value near the horizon. Also as the optical thickness increases, the maximum of the transmitted radiance moves from the incident direction toward the zenith. The variations in the flux and the mean optical path are also discussed. Author

N67-39077*# Volt Technical Corp., Washington, D. C.
PHOTOMETRIC OBSERVATIONS OF TWILIGHT AS A METHOD OF STUDY OF THE UPPER STRATOSPHERE
M. M. Shtaude 29 Sep. 1967 13 p Transl. into ENGLISH from the Russian Rept.
(Contract NAS5-12487)
(NASA-CR-89335; SE-AA-AI-10650) CSCL 04A

Chapter summaries of work on upper stratosphere study by photometric observations of the twilight are presented. The summaries briefly cover indirect methods of stratosphere study and the role of the twilight method; air reflectance according to Fesenkov's visual observations of twilight brightness; the dependence of turbid medium reflectance on the kind and quantity of scattered particles, and Rayleigh and Mies theories of scattering from compact particles; molecular scattering in gases; atmospheric composition and density at varying altitudes; a simplified theory of twilight; and the working up of twilight photographs. Also included are excerpts from Chapter 2 on the role of the dust layer. R.N.A.

N67-39080# Los Alamos Scientific Lab., N. Mex.
GROUND VIBRATION CHARACTERISTICS OF MESITA DE LOS ALAMOS
M. Dean Keller, Eric S. Foster, and Frank H. Werner (Coast and Geodetic Surv., Albuquerque, N. Mex.) [1967] 31 p refs Presented at the Symp. on Wave Propagation and Dyn. Properties of Earth Mater., Albuquerque Prepared Jointly with Coast and Geodetic Surv., Albuquerque, N. Mex.
(Contract W-7405-ENG-36)
(LA-DC-8718; CONF-670804-1) CFSTI: HC $3.00/MF $0.65

The foundation material which must support the Los Alamos Meson Physics Linear Accelerator is a welded tuff of volcanic origin. Its physical properties are neither perfectly elastic nor inelastic, and its characteristics with respect to amplification or attenuation of vibrations were unknown to a satisfactory degree. Prior to design of critical components for the Meson Physics Linear Accelerator, it was necessary to determine these characteristics with sufficient reliability to provide for economical designs of buildings and critical machine components. Those forces which could be duplicated, such as heavy truck traffic and impact loading, were duplicated and the vibrations resulting therefrom were recorded. Natural microseisms were recorded. High explosives were detonated on Mesita de Los Alamos, and the relationship between size of charge, distance, frequency, velocity, acceleration, displacement and Fourier spectra coefficients was established. The results obtained from these tests will be used in the dynamic analysis of components comprising this facility. Two tests of this series, the impact tests and the high explosive detonation tests, are described. Author (NSA)

N67-39084# Lightning and Transients Research Inst., Minneapolis, Minn.
EXPERIMENTAL STUDY OF TRIGGERED NATURAL LIGHTNING DISCHARGES Final Report
M. M. Newman, J. R. Stahmann, and J. D. Robb Washington, FAA, Mar. 1967 59 p refs
(Contract FA-66-NF-156)
(DS-67-3)

Studies of the natural lightning discharge channel have been continued using a triggering technique during which seventeen strokes were triggered out of twenty-three attempts. The discharges were triggered by firing a rocket carrying a fine wire to an altitude of about 100 to 400 meters when electric field meters indicated a discharge was probable. The studies showed clearly in the Fastax photographs, the current oscillograms, and in the still photographs, the existence of a low current continuing component lasting up to 0.8 seconds following nearly every initial high current stroke. High current restrikes were found after nearly every stroke with as many as eleven restrikes to a single lightning discharge. Blast pressure measurements showed only slightly higher peak pressures than measured previously from triggered natural lightning discharges. This is of interest in relation to possible structural damage to aircraft and also in relation to shock wave effects on flame propagation in aircraft fuel vents. High speed motion pictures of the discharge clearly showed the snake-like motion of the channel which is of interest in evaluation of stroke sweeping effects near aircraft. Author

N67-39128# Bureau of Mines, Washington, D. C.
CLINTON HEMATITIC SANDSTONE DEPOSITS, BUTT MOUNTAIN AREA, GILES COUNTY, VA.
George E. Fish, Jr. Jun. 1967 43 p
(BM-RI-6966)

Large hematitic sandstone deposits in the Clinton formation of the Butt Mountain area of northeastern Giles County, Virginia were investigated as a possible future source of iron. Beneficiation studies were made of three composite hematitic sandstone drill core samples representing separate beds containing 14.6, 19.8 and 20.0% iron. Major mineral constituents of the samples were hematite, quartz, and sericite. Conventional mineral dressing methods could not be used because of the easy sliming properties and iron oxide mineralization of the samples. Beneficiation methods, such as sink–float attrition scrubbing, dry magnetic separation, and flotation were unsatisfactory. The best concentrates were obtained by reduction roasting, fine grinding, and magnetic separation, and contained 58.7, 53.9, and 49.5% iron, respectively. Their respective recoveries were 91.7, 92.6, and 89.0%. However, these medium grade iron concentrates are relatively high in phosphorus and would require agglomeration before they could be used as a furnace feed. R.N.A.

N67-39130*# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
DENSITY AND TEMPERATURE FLUCTUATIONS IN THE DAYTIME F REGION OF THE IONOSPHERE
Joe R. Doupnik 10 Aug. 1967 157 p refs
(Grant NsG-134-61)
(NASA-CR-89305; SR-302) CFSTI: HC $3.00/MF $0.65 CSCL 04A

Large amplitude electron density and temperature fluctuations in the daytime F region were observed at Puerto Rico during incoherent backscatter experiments on quiet days. During the fluctuations, the electron densities were observed to change inversely to the electron temperatures. Model computations of separate density and temperature profiles indicated that instabilities of the coupled density-temperature system were not responsible for these fluctuations. Local drifting irregularities and solar flux variations were shown to be not responsible by data from a network of

spaced ionosondes. Electrodynamic drifts associated with the dynamo current system were shown to be at variance with vertical transport velocities computed from the experimental backscatter data. Data on one day indicated possible internal gravity wave induced fluctuations, but other fluctuations were not due to waves. A low latitude system of neutral winds was suggested as a cause of the fluctuations, but there are large differences between the required winds and current global wind models. Author

N67-39137*# Pennsylvania State Univ., University Park. Dept. of Electrical Engineering.
IONOSPHERIC D-REGION ELECTRON DENSITIES AND COLLISION FREQUENCIES DURING THE QUIET SUN PERIOD MEASURED BY MEANS OF RADIO WAVE INTERACTION, PART 1, JANUARY 1, 1964–JUNE 30, 1964
A. J. Ferraro and H. S. Lee 20 Sep. 1967 23 p refs
(Grants NSF GP-4622; NSF GP-848)
(SR-308(D))

This report presents electron density and collision frequency profiles of the D-region obtained during the IQSY Program with a radiowave interaction facility. This report covers the period of 1 January 1964 to 30 June 1964 and is the first of a series of four reports to cover the measurement period of 1 January 1964 to 31 December 1965. Average seasonal and diurnal profiles of electron density are presented along with monthly mean values of collision frequency. Author

N67-39140# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL. PART VI: DATA PROCESSING AND PRELIMINARY RESULTS [DAS KIELER LUFTSCHAUER-EXPERIMENT. TEIL VI. DATENVERARBEITUNG UND VORLAEUFIGE ERGEBNISSE]
E. Boehm May 1967 13 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-43)

The processing of scintillation counter data of the air shower experiment at Kiel is described. The determination of the total particle number, core position, direction of incidence as well as steepness of the lateral distribution is obtained by a best fit method, comparing a predetermined lateral distribution function with the scintillator data. Preliminary results of the evaluations are given. Author (NSA)

N67-39147 Joint Publications Research Service, Washington, D. C.
SOVIET-BLOC RESEARCH IN GEOPHYSICS, ASTRONOMY, AND SPACE, NO. 165
4 Oct. 1967 147 p refs
(JPRS-42836; TT-61-11147-165) CFSTI: $3.00

Abstracts, summaries, and article translations on Soviet-Bloc research in astronomy, meteorology, oceanography, terrestrial geophysics, upper atmospherics, and space research, are presented. Areas discussed include: 1) solar activity, 2) lunar surface features, 3) light scattering, 4) lasers as meteorological tools, 5) planetary atmospheres, 6) cloud covers and rainfall, 7) snow cover, 8) determination of sea floor and organic composition of marine sediments, 9) ocean currents and velocities, 10) seismic recordings, and 11) earth and atmospheric magnetic fields. Other related topics are also discussed. Bibliographic information accompanies each article. L.S.

N67-39156 Massachusetts Inst. of Tech., Cambridge. Dept. of Geology and Geophysics.
POST-DOCTORAL PROGRAM IN SEISMOLOGY Annual Report, 1 Jul. 1966–30 Jun. 1967
30 Jun. 1967 25 p refs
(Contract AF 49(638)-1763; ARPA Order 292-67; Proj. Vela-Uniform)
(AD-657087)

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N67-39157 Massachusetts Inst. of Tech., Cambridge.
SYNTHESIS OF DILATATION AND ROTATION SEISMOGRAMS
M. Saito *In its* Post-Doctoral Program in Seismology 30 Jun. 1967 p 2–8 (See N67-39156 23-13)

Numerical procedures for computing dilatation and rotation seismograms from an array of identical 3-component stations are described. Preliminary results indicate remarkable differences between dilatation and rotation seismograms. A comparison of phase angles between strain seismograms and vertical, longitudinal, and transverse component seismograms is used to identify several modes of propagation and propagation direction. E.C.

N67-39158 Massachusetts Inst. of Tech., Cambridge.
PARTICLE MOTION—MODE FILTERS
R. Turpening *In its* Post-Doctoral Program in Seismology 30 Jun. 1967 p 9–12 (See N67-39156 23-13)

Earlier work is briefly reviewed on studies of analog-optical mode filtering schemes with applications to seismic data for enhancing rectilinear motion in the presence of retrograd elliptical motion. Analytical expressions for the output of two optical filters are given. The expressions indicate that the filters operate by adding certain input traces that have been shifted in phase by ninety degrees. Progress in other particle motion filter investigations is mentioned. E.C.

N67-39159 Massachusetts Inst. of Tech., Cambridge.
STRUCTURES OF THE EARTH'S CORE
E. Husebye *In its* Post-Doctoral Program in Seismology 30 Jun. 1967 p 13–14 (See N67-39156 23-13)

Preliminary results from an evaluation of a series of earth core models are given. Comparison of velocity distribution and other model characteristics with observed core phases revealed certain discrepancies which are cited. E.C.

N67-39160 Massachusetts Inst. of Tech., Cambridge.
PARTIAL DERIVATIVES OF THE PHASE VELOCITY OF SURFACE WAVES WITH RESPECT TO ANISOTROPY FACTORS
M. Saito *In its* Post-Doctoral Program in Seismology 30 Jun. 1967 p 15–18 (See N67-39156 23-13)

Perturbations of phase velocities due to small changes in earth models are calculated from the partial derivative data of phase velocity. The same technique is applied to compute dispersion curves for slightly anisotropic models. Author

N67-39243*# Southwest Center for Advanced Studies, Dallas, Tex.
THE MODULAR AURORAL PROBE
W. J. Heikkila, ed. Sep. 1967 109 p
(Contract NSR-44-004-041)
(NASA-CR-89283; DASS-67-5) CFSTI: HC $3.00/MF $0.65
CSCL 04A

A description of a Modular Auroral Probe (MAP) payload for rocket investigations of auroral zone disturbances is presented. The payload includes a parachute for recovery purposes with a view to repeated use of the instrumentation. The modular concept for experiments was then adopted in order to permit changes in the experiments as suggested by experience. The modular concept involved the generous provision of services such as power, timing signals, umbilical lines, and telemetry channels. The auxiliary equipment developed to meet this need is described in some detail. The first payloads carried six experiments as follows: energetic particle detectors, soft electron spectrometer, photometers, frequency shift capacitance probe, Langmuir probe, and a pulse receiver. The principal theoretical and instrumental features of the different probes are presented in brief form. Author

N67-39248*# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
OBSERVATIONS OF VLF HISS AT VERY LOW L VALUES
Donald A. Gurnett Aug. 1967 24 p refs
(Grant NGR-16-001-043; Contract Nonr-1509(06))
(NASA-CR-89280; Rept.-67-48) CFSTI: HC $3.00/MF $0.65
CSCL 04A

Observations of intense bursts of very-low-frequency (VLF) radio noise at low altitudes near the magnetic equator are reported using data from the Injun 3 satellite. The spectral characteristics of these radio noise events typically consist of hiss extending from about 1 kHz to above 8.8 kHz (the highest frequency measured). These equatorial VLF hiss events are very similar to VLF hiss commonly found near the auroral zone. During the ten month lifetime of Injun 3, a total of ten VLF hiss events occurred below 35 degrees magnetic latitude with noise spectral densities exceeding 3×10^{-10} gamma^2 Hz^{-1}. All of these events occurred below 350 km altitude and at L values less than 1.2. Nine of the events occurred below 20 degrees magnetic latitude. These equatorial VLF hiss events are noteworthy because of their unusual region of occurrence. Whereas auroral zone VLF hiss may be attributable to the precipitation of energetic ($E \leq 10$ keV) charged particles, no comparable flux of charged particles is known to exist in the region where the equatorial VLF hiss occurs. Author

N67-39301# Bureau of Mines, Spokane, Wash.
AN EVALUATION OF THE WESTERN PHOSPHATE INDUSTRY AND ITS RESOURCES. PART 4: WYOMING AND UTAH
J. S. Coffman and A. L. Service Apr. 1967 166 p refs
(BM-RI-6934, Pt. 4)

Wyoming has an estimated 700 million tons and Utah more than 2.5 billion tons of 10% P_2O_5 phosphate rock with some future economic potential. Wyoming also has 24 and 18% P_2O_5 rock resources of 250 and 450 million tons, respectively; while Utah has 31, 24, and 18% rock reserves of 33 million, 222 million, and 2.2 billion tons, respectively. These resources are all located above the local drainage levels and do not include latent resources. Some areas of western Wyoming contain vast quantities of phosphate rock in minable units, but are classed as latent areas because of their remote location. These areas have an estimated .7, 2, and 3 billion tons of 24, 18, and 10% phosphate rock, respectively. The Snake River Range of Idaho and Wyoming has roughly 21, 106, 177, and 214 million tons of potential resources in the 31, 24, 18, and 10% grade categories, respectively. The remote areas also contain large amounts of latent rock. The possible exploitation of the undeveloped deposits in Wyoming and Utah depends on market conditions, which are presently unfavorable because of vast available resources and the rapid expansion of facilities at these regions. Author

N67-39313* Geological Survey, Menlo Park, Calif.
[INFRARED INVESTIGATIONS] Status Report, 1 Jul.–30 Sep. 1966
Robert M. Moxham 30 Sep. 1966 8 p refs
(NASA Order R-146)
(NASA-CR-79136) CSCL 08G

The completion of aerial infrared surveys is reported for nine areas of geothermal interest in the states of California and Washington. Aerial photographs and radiometric data were obtained in all of these areas in addition to the infrared scannings. Instrumentation, methods, problems, and some results concerning spectral emittance, fumarolic activities, thermal anomalies, infrared luminescence, and geyser activities are discussed; the photographs and images, however, are not presented in this report. K.W.

N67-39325# Max-Planck-Institut fuer Kernphysik, Heidelberg (West Germany).
RARE GASES IN STONY METEORITES
J. Zaehringer [1967] 55 p refs
(MPIH-1967/V/11)

The contents and isotopic composition of He, Ne and Ar in 81 stony meteorites have been determined. The exposure ages of diogenites are clustered around 20 m.y.. The H-chondrites, the L-chondrite and the carbonaceous chondrites contain He and Ne as primordial components. The contents of ^{84}Kr and ^{132}Xe and the $^{129}Xe/^{132}Xe$ ratio have also been determined in 92 stony meteorites. Not only the ^{84}Kr and ^{132}Xe contents but also the content of the ^{128}Xe-excess are proportional to the primordial ^{36}Ar content over a larger range. The $^{129}Xe/^{132}Xe$ ratios of all ordinary chondrites lie between 1 and 2 and all enstatite chondrites have ratios between 3 and 6. It is concluded that all ordinary chondrites had initially about the same Xe/I ratio and that most of them lost a large fraction of their primordial rare gases after the ^{129}I decay while the high temperature fraction retained all of the ^{129}Xe. Author

N67-39326 Joint Publications Research Service, Washington, D. C.
SEISMICITY OF YAKUTIYA
V. M. Kochetkov 21 Sep. 1967 98 p refs Transl. into ENGLISH of the book "Seysmichnost' Yakutii" Moscow, Nauka Publishing House, 1966 p 3–92
(JPRS-42710; TT-67-33337) CFSTI: $3.00

Seismological research and zoning in the USSR is discussed with respect to its history and the problems it poses for the utilization of natural resources in northeastern sections. Determination of the epicenters of earthquakes is considered and earthquakes are described in terms of energy. The pre-upper paleozoic history, upper paleozoic–mesozoic stage of development, and tectonic zoning are briefly examined. Active seismic zones delineated on the basis of geological data are also discussed. S.P.

N67-39336*# National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, Md.
RECENT MEASUREMENTS OF THE LOWER THERMOSPHERE STRUCTURE
N. W. Spencer, G. R. Carignan (Mich. Univ., Ann Arbor, Mich.), and D. R. Taeusch (Mich. Univ., Ann Arbor, Mich.) Sep. 1967 17 p refs
(NASA-TM-X-55859; X-623-67-480) CFSTI: HC $3.00/MF $0.65
CSCL 04A

Measuring of the concentration of neutral particles in the thermosphere poses difficult problems. Recent technological advances now permit new measurements, and the new data show high variability of the temperature and concentration of the constituents in response to variations in the energy absorbed. For example, at times of very low solar activity, densities deduced from satellite drag show little diurnal variation at 200 kilometers, but substantial variation as the altitude increases, reflecting approximately a factor of three (maximum to minimum) at 300 kilometers. In contrast, densities and temperatures measured in the lower thermosphere by mass spectrometer techniques at times of low solar activity show significant variation. At 200 kilometers, where the concentrations of molecular nitrogen and atomic oxygen are approximately equal, the ratio of maximum daytime to minimum nighttime is observed to be approximately 1.8. Recent data show less variability at the 200 kilometer level with increasing solar activity. Author

N67-38367# Bureau of Mines, Spokane, Wash.
AN EVALUATION OF THE WESTERN PHOSPHATE INDUSTRY AND ITS RESOURCES. PART 5: TRENDS AND OUTLOOK
A. L. Service and N. S. Petersen (Bur. of Mines, Albany, Oreg.) May 1967 139 p refs
(BM-RI-6935, Pt. 5)

This report includes an evaluation of the trends and outlook for the Western phosphate industry through 1975 as part of the Bureau's program to determine the rate at which the Nation's mineral resources are being utilized. The first part of this report is concerned with the relationship between the Western phosphate industry and that of the United States and the world. It describes the principal phosphate deposits and discusses production, export, and import of phosphate rock and marketable products. The second part of the report is concerned with the Western phosphate industry and discusses trends and outlook through 1975. Projections for the utilization of phosphate rock, phosphate fertilizers, and elemental phosphorus have been developed and extended through 1975 in an effort to provide data and information pertaining to the rate of depletion of the Nation's phosphate resources. Author

N67-38379# International Business Machines Corp., Cambridge, Mass. Advanced Space Systems Dept.
CAMBRIDGE ATMOSPHERIC DENSITY NUMERICAL INTEGRATION PROGRAM (CADNIP) Final Report, Jun. 1964–May 1967
Arnold S. Bramson and Jack Slowey Aug. 1967 63 p refs
(Contract AF 19(628)-4192)
(AFCRL-67-0403; AD-657038)

This report describes a series of computer programs designed to determine atmospheric density from an analysis of satellite observations. The adopted approach consists of a numerical integration procedure combined with a differential correction scheme where discrepancies between computed and observed satellite position and velocity are reconciled by adjusting the assumed atmospheric model, thereby yielding corrected or refined density data. An important advantage of this technique is its applicability to satellites entering the decay stage where the effects of atmospheric drag are considerable and where a relatively short time span of observations may be available. Numerical results and their implications along with recommendations for future research and development are presented. Finally, a complete users manual is included as a separate appendix. Author (TAB)

14 INSTRUMENTATION AND PHOTOGRAPHY

Includes design, installation, and testing of instrumentation systems; gyroscopes; measuring instruments and gages; recorders; transducers; aerial photography; and telescopes and cameras.

N67-38086# David Taylor Model Basin, Washington, D. C. Aerodynamics Lab.
A DESCRIPTION OF FOUR WIND-TUNNEL DYNAMIC MEASURING TECHNIQUES
Edwin B. O'Neill and Kenneth A. Phillips Mar. 1967 60 p refs
(DTMB-2296; DTMB-AERO-1122; AD-655825)

Results of a study comparing the damping-in-pitch parameter as obtained from four experimental techniques are presented. Each of the methods is briefly described and measured values given. The four methods used were: a single degree-of-freedom free oscillation, a single degree-of-freedom forced oscillation, a three-degree-of-freedom free oscillation, and a free-flight scheme. The damping-in-pitch compares reasonably well, though some data scatter exists. The forced oscillation measurements are shown to yield the more consistent values. All of the experimental schemes are shown to yield highly accurate static force and moment coefficient slopes. Author (TAB)

N67-38092# Michigan State Univ., East Lansing. Ultrasonics Lab.
SUBHARMONIC GENERATION IN AN ACOUSTIC FABRY–PEROT INTERFEROMETER
Jack A. Bamberg May 1967 50 p refs
(Contract Nonr-2587)
(TR-16; AD-657185)

Above a certain energy density threshold in an intense ultrasonic standing wave, subharmonics of the driving frequency are sometimes present. To study this effect, an acoustic Fabry-Perot interferometer was constructed, consisting of two air-backed quartz transducers submerged in water. One of the transducers is driven at frequencies around its 3 MHz resonance. Electronic analysis of the waveforms present in the cavity is accomplished with a spectrum analyser connected to the other quartz transducer. Optical methods are used as a supplementary means of analysis. It was observed that subharmonics exist only at frequencies for which the cavity is in resonance and always occur in pairs, such that the sum of their frequencies is equal to the driving frequency. These discrete frequencies appear only in regions near integral sub-multiplies of the driving frequency. The pressure in the cavity at the onset of subharmonic oscillation may be as low as 1.5 atmosphere. In this study, subharmonics were obtained only when the cavity reflector had a frequency dependent reflection coefficient. Author (TAB)

N67-38106# Hawaii Inst. of Geophysics, Honolulu.
THE TROPICAL UPPER TROPOSPHERIC TROUGH AS A SECONDARY SOURCE OF TYPHOONS AND A PRIMARY SOURCE OF TRADEWIND DISTURBANCES Final Scientific Report, 1 Feb. 1964–1 Jan. 1967
James C. Sadler Mar. 1967 53 p refs
(Contract AF 19(628)-3860)
(HIG-67-12; AFCRL-67-0203; AD-657021)

Surface and 250 mb analyses for a 9-day summer period over the North Pacific, together with satellite photographs, are shown to illustrate (1) the development of a typhoon and a tropical storm from cyclonic cells in the tropical upper tropospheric trough, and (2) the dominance of the trough in producing tradewind weather. Author (TAB)

N67-38136# National Research Council of Canada, Ottawa (Ontario). Div. of Mechanical Engineering.
INSTRUMENTATION FOR A TIDAL RIVER MODEL
H. A. Neu and E. S. Turner Mar. 1967 20 p ref
(NRC-9858; DME-Misc.-42) CFSTI: HC $3.00/MF $0.65

Equipment is described for controlling water levels in an hydraulic model having scales of 1:1440 by 1:144 in accordance with prototype tides having three constituents. Remote recording water level and velocity measuring instruments of simple construction are described also. Author

N67-38229*# Israel Program for Scientific Translations, Ltd., Jerusalem.
AN AIR-FILLED SPARK CHAMBER
N. N. Nurgozhin and R. A. Nam *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 278–280 refs (See N67-38201 23-29)

A brief description of the design and operation is given of a small experimental spark chamber, constructed as a step toward building a large, multilayer chamber to record showers caused by high energy cosmic ray particles. The chamber acts as a spark counter with pulse voltage supply, and is controlled by a telescope consisting of two rows of MS-6 Geiger counters. Preliminary data are described for various combinations of the number of electrodes and interelectrode distance. The results are considered to indicate the feasibility of utilizing large chambers. N.E.N.

N67-38230*# Israel Program for Scientific Translations, Ltd., Jerusalem.
A SPARK COUNTER FOR RECORDING COSMIC-RADIATION PARTICLES
M. I. Pak and Yu. T. Lukin *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 281–285 refs (See N67-38201 23-29)

The design and efficiency of a large area spark counter, operating in conjunction with an ionization calorimeter and photographic emulsions, are briefly reported. The efficiency was determined as a function of potential difference between electrodes for gaps of 1, 1.5, and 2 mm. It was found that the efficiency depends on electric field strength and also on structural features. A counter with an area of 23×30 cm^2 and 1.5 mm electrode gap is recommended. N.E.N.

N67-38232*# Israel Program for Scientific Translations, Ltd., Jerusalem.
OPERATION OF A NEUTRON MONITOR AND μ-MESON TELESCOPE
R. Z. Denikaev, E. V. Kolomeets, L. V. Kozak, L. A. Mirkin, B. A. Prilepskii et al *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 291–293 refs (See N67-38201 23-29)

Modifications in the circuits and construction of the monitor are outlined, and it is reported that as a result of the alterations the operation of the monitor has been stable for four years. The design of the telescope, for recording continuously the directional intensity of the hard cosmic ray component, is briefly described. N.E.N.

N67-38233*# Israel Program for Scientific Translations, Ltd., Jerusalem.
A POSSIBLE CAUSE OF INSTRUMENTAL ERRORS FOR A NEUTRON MONITOR
I. N. Kapustin and A. V. Kapustina *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 294–296 (See N67-38201 23-29)

The oxide film formed at the contacts of the high voltage and the central counter electrodes was investigated as a source of the deviations of statistical scatter from the Poisson distribution. The potentials on the counter case and on the contacts are considered, and all contacts which might contribute to spurious scatter of the counts were soldered. Distribution curves for actual readings before and after soldering were obtained, and the post-soldering curve was found to fit the Poisson curve well. N.E.N.

N67-38262*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A DESCRIPTION OF FOUR FAST SLITLESS SPECTROGRAPHS
Gale A. Harvey Washington, NASA, Oct. 1967 39 p refs
(NASA-TN-D-4145) CFSTI: HC $3.00/MF $0.65 CSCL 20F

A description, comparison, and short discussion of four fast slitless spectrographs for use in low-light-level research are given. The spectrographs include three catadioptric systems, the super Schmidt meteor camera, the baby Schmidt, and the Maksutov and one refractive optical system, the super Farron. The baby Schmidt and the Maksutov systems have fused-silica transmission elements. Except for the super Schmidt camera, which utilizes a light flint mosaic prism, all systems utilize objective transmission diffraction gratings. The four systems discussed have low-light-level spectroscopic recording capability. The super Schmidt has the largest field, 57°; the baby Schmidt and Maksutov have the broadest effective spectral range (3200 angstroms to 9500 angstroms); and the super Farron features the greatest versatility and portability. Author

N67-38301# Oak Ridge National Lab., Tenn.
INSTRUMENTATION AND CONTROLS DIVISION Annual Progress Report, Period Ending Sep. 1, 1966
Jun. 1967 242 p refs
(Contract W-7405-ENG-26)
(ORNL-4091) CFSTI: HC $3.00/MF $0.65

A collection of reports are presented dealing with nanosecond circuitry and techniques, pulse counting and analysis, miscellaneous electronics development, instruments for biomedical research, detectors of ionizing particles and radiation, radiation monitoring, instrumentation for automatic control and data acquisition, hard wired systems, data collection and analysis, process instrumentation and control systems engineering, process instrumentation development, reactor instrumentation and controls, in-pile experiments, instrumentation for reactor test loops, instrumentation maintenance, and support for a high voltage accelerator program. R.N.A.

N67-38336# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
AN X-RAY TELEVISION SYSTEM FOR ELECTRONIC PARTS INSPECTION
Donald B. Gilmore and Francis T. Marcellino Jul. 1967 45 p refs
(Contract NOw-62-0604-c)
(TG-920; AD-656892)

The report describes an X-ray television system for use in inspection and evaluation of electronic parts. This type of system offers several advantages over a conventional (two view, film) X-ray inspection system including: (1) The part may be translated, rotated, or tilted while being inspected. This allows an infinite number of views, lessening the chance of a defect going undiscovered. (2) Electro-mechanical parts, such as relays or switches, may be operated while being viewed. (3) The system may be adjusted for optimum resolution of the part structure, or of any suspected defect, while the device is being viewed. No waiting for film development and evaluation is required. The ability of the system to resolve details of the internal structure of electronic

parts compares favorably with that of fine-grain film X-ray techniques. The X-ray television system is being used for incoming inspection, failure analysis, comparative evaluation of parts from different vendors, and evaluation of the effects of environmental tests on parts. Photographic examples of these various uses are included in this report. The report also discusses the advantages and limitations of X-ray television as an inspection tool and describes the X-ray television inspection system installation. Author (TAB)

N67-38609# Sandia Corp., Albuquerque, N. Mex.
CALIBRATION OF SHOCK ACCELEROMETERS
Ralph W. Kelley Jun. 1967 29 p refs Presented at the 22d Instr. Automation Conf. and Exhibit, Chicago
(Contract AT(29-1)-789)
(SC-DC-67-1785; CONF-670903-6) CFSTI: HC $3.00/MF $0.65

Although a wide variety of facilities and techniques have been used for shock calibration, the methods which are most widely used in calibration laboratories today fall into two general categories, the velocity change method and the impact-force method. These two methods are discussed together with some specific samples of shock calibration systems which utilize one of these basic methods. The following shock calibration systems are discussed. Drop-Ball Calibrator, Model 2965, manufactured by Endevco Corp; Ballistic Pendulum Shock Calibrator, developed by Sandia Laboratory, Albuquerque; Impact-Force Shock Calibrator, Model 894K, manufactured by Kistler Instrument Corp.; and Zatter Electromagnetic Shock Facility, developed by Sandia Laboratory, Livermore. The principle of operation of each calibrator is discussed together with the capabilities of each device. Typical calibration accuracy figures which can be expected on each calibrator are given. Author (NSA)

N67-38634# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Physics Div.
PERFORMANCE OF Ge(Li) DETECTORS OVER A WIDE TEMPERATURE RANGE
E. Sakai, H. L. Malm, and I. L. Fowler May 1967 38 p refs Presented at Gatlinburg Conf. on Semicond. Nucl. Particle Detectors and Circuits, Tenn., 15–18 May, 1967
(AECL-2762) CFSTI: HC $3.00/MF $0.65

The properties of six Ge(Li) detectors as γ-ray spectrometers have been measured over the temperature range 5° to 220°K. The detectors were selected to show a wide range of charge trapping effects—three exhibited predominantly electron trapping, two hole trapping, and the other, a very good spectrometer, showed very little trapping of either carrier. Optimum γ-ray energy resolution for all six detectors occurred in the range 20°–40°K. As the temperature was reduced it was possible to increase the operating voltage giving some further improvement in resolution. Below 20°K the γ-ray resolution deteriorated rapidly due to the appearance of a slow rising component (up to 20 μs) in the preamplifier pulses. With high applied voltage, the slow component disappeared and high-resolution performance was possible down to $\approx$10°K. The detectors were still p-i-n diodes with unchanged sensitive volume (same capacitance) at temperatures down to 5.2°K. Transit times were measured and were strongly temperature dependent having a minimum for both electrons and holes in the range 30°–60°K. Author

N67-38665*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
A FAR ULTRAVIOLET POLARIZATION ANALYZER FOR ROCKET USE
Donald F. Heath Sep. 1967 25 p refs
(NASA-TM-X-55948; X-622-67-423) CFSTI: HC $3.00/MF $0.65
CSCL 20F

A rocket version of a far ultraviolet polarization analyzer has been constructed to measure the polarization of resonantly scattered sunlight. The rotating, 8-plate, LiF analyzer has principal transmittances which vary from $k_1 = 0.088$ and $k_2 = 0.0037$ at H Lyman alpha to $k_1 = 0.623$ and $k_2 = 0.075$ at 2500 Å. The region from 1200 to 2000 Å is divided into four intervals by using filters of CaF_2, BaF_2, and Al_2O_3 in conjunction with the "solar blindness" of the CsI photocathode. The calculated polarizations, which are a direct consequence of the Zeeman effect, are given for some of the ultraviolet multiplets which could contribute to the ultraviolet day airglow in planetary atmospheres. Departures from the calculated polarizations may be due to the effects of multiple scattering, collisional excitation, and hyperfine structure. The observed polarization of the sum of the lines which constitute a multiplet is dependent upon the relative population (a measure of the temperature) of the ground states of the multiplet. Author

N67-38770# Princeton Univ., N. J. Plasma Physics Lab.
PHASE-MODULATED MICROWAVE INTERFEROMETER
W. P. Ernst *In its* Plasma Phys. Lab. May 1967 p 386–388 ref (See N67-38725 23-25)

Described is a microwave interferometer with fixed frequency signal operation and phase-modulation of the transmitted signal in one leg of a balanced bridge network. The output of the klystron signal source is split, with the largest amount of power going to the waveguide transmission leg containing the plasma medium. After being phase modulated, this part of the signal together with the original carrier is applied through a directional coupler where a fringe signal generates. A self-calibration feature is provided by about 2π radians of phase shift between successive bands. G.G.

N67-38771# Princeton Univ., N. J. Plasma Physics Lab.
FAST-SWEEP SPECTRUM ANALYZER
A. H. Skislak *In its* Plasma Phys. Lab. May 1967 p 389–392 refs (See N67-38725 23-25)

Designed and constructed was a fast sweep spectrum analyzer for investigating noise pulses containing frequencies in the 10 MHz to 50 MHz range. Frequency scan of this analyzer was achieved by two frequency modulated microwave klystrons operating as part of the oscillator system; klystron outputs were mixed in a detector diode and the output signal used as FM local oscillator signal. Scope presentation and analyzer sweep were synchronized by using the scope sweep output waveform as the modulating voltage for the klystrons. G.G.

N67-38779# Princeton Univ., N. J. Plasma Physics Lab.
USE OF THE MULTICHANNEL TAPE RECORDER AS AN ENGINEERING TOOL
S. D. Simon *In its* Plasma Phys. Lab. May 1967 p 437–442 (See N67-38725 23-25)
(Grant NSF GP-579)

In the development and fabrication of high-energy systems for controlled thermonuclear research, a large percentage of available engineering manpower is expended in testing and debugging new equipment and systems which have developed malfunctions. We have found that the time spent on these labors can be reduced considerably by the use of multichannel analog tape recorders. The recorders are used as on-line data-acquisition systems in new system tests and as auto-stop loop machines on equipment trouble shooting. Author

N67-38799# California Univ., Livermore. Lawrence Radiation Lab.
COMPUTER PROCESSING OF PHOTOGRAPHIC INFORMATION

Richard W. Conn 15 May 1967 12 p refs Presented at the Spring Joint Computer Conf., Atlantic City, 18–20 Apr. 1967
(Contract W-7405-ENG-48)
(UCID-15144; CONF-670403-2) CFSTI: HC $3.00/MF $0.65

Some experiments in digitizing photographs and subsequently reproducing them on a computer-controlled microfilm recorder are described. An appraisal of these experiments is given.
Author (NSA)

N67-38832# Sandia Corp., Albuquerque, N. Mex.
IN-PLACE CRYSTAL ACCELEROMETER VOLTAGE CALIBRATION SYSTEM
J. D. Tebbs [1967] 17 p Presented at the 22nd Instr.-Automation Conf. and Exhibit, Chicago
(Contract AT(29-1)-789)
(SC-DC-67-1804; CONF-670903-3) CFSTI: HC $3.00/MF $0.65

An in-place crystal accelerometer voltage calibration system is described which is presently being employed to calibrate high impedance voltage amplifiers and magnetic tape recorders used to collect vibration data at Sandia's environmental test facilities. It is basically a master 400Hz power oscillator driving many channels of passive dividers set to simulate the accelerometer voltage. The system is unique in that it compensates for the line load capacitance between accelerometer and amplifier.
NSA

N67-38834# Sandia Corp., Albuquerque, N. Mex.
DISTORTIONS OF CONTROLLED TRANSIENTS BY SHOCK MONITORING SYSTEMS
R. O. Brooks and J. A. Guzman [1967] 46 p refs Presented at the 22nd Instr.-Automation Conf. and Exhibit, Chicago
(Contract AT(29-1)-789)
(SC-DC-67-1833; CONF-670903-4) CFSTI: HC $3.00/MF $0.65

A method was developed to electronically generate controlled clean and noisy transients. These transients are used as substitutions of possible accelerometer outputs that may occur during shock tests. The electrical transients are fed into different shock monitoring instrumentation circuits, some of which distort the signals producing zero shift and/or filtered pulse distortions, thereby affecting record interpretation. The noisy transients have revealed that sometimes there are circuit deficiencies not found using comparable sustained wave or clean simple pulse signals.
Author (NSA)

N67-38846# Kiel Univ. (West Germany)
A MAGNETIC SPECTROGRAPH HAVING A HIGH ANGULAR RESOLUTION FOR A STUDY OF THE MOMENTUM SPECTRUM OF COSMIC RAY MUONS WITHIN THE RANGE 10 GeV/c<p<5000 GeV/c [DER AUFBAU EINES HOCHAUFLOESENDEN MAGNETISCHEN SPEKTROMETERS ZUR IMPULSBESTIMMUNG DER ULTRASTRAHLUNGS-MUONEN IM BEREICH 10–5000 GeV/c]
E. Kraft Apr. 1967 32 p refs In GERMAN
(BMwF-FBK-67-33)

A magnetic spectrograph is described that can be used to measure the muon spectrum up to the energy of 5×10^{12} eV. For deflection of the particles a solid iron magnet is used. The particle track is determined by six spark chambers. For good track accuracy, the spark chambers were triggered from avalanche. The total apparatus can be turned in vertical direction to any desirable angle. The purpose of the measurements is to determine the muon spectrum and their charge ratio. It is planned to study muon interactions with matter.
Author (NSA)

N67-38908# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
STABILIZATION SYSTEM OF TIME-OF-FLIGHT SPECTROMETER OF NANOSECOND RANGE [SISTEMA STABILIZATSII VREMENNOGO SPEKTROMETRA NONOSEKUNDNOGO DIAPAZONA]
V. G. Lepshin, M. N. Omel'yanenko, V. I. Rykalin, A. N. Sinaev, V. P. Khromov et al 1967 19 p In RUSSIAN
(JINR-P13-3342)

A stabilization system is described of a time-of-flight nanosecond range spectrometer using two reference time intervals between the womps from the semiconductor pulse lamps. The system allows stabilization of the threshold and the transmission factor. This system includes the whole spectrometer channel beginning from the photomultiplier up to the memory input. Thanks to the stabilization used, the permanent stability of the center of gravity positions of the measured time distributions is equal to $\pm3.10^{-12}$ sec.
Author (NSA)

N67-38909# Joint Inst. for Nuclear Research, Dubna. Lab. of Nuclear Problems.
THRESHOLD CHERENKOV COUNTER WITH A PERSPEX RADIATOR [POROGOVYI CHERENKOVSKII SCHETCHIK S RADIATOROM IZ PLEKSIGLASA]
V. I. Petrukhin, V. S. Pogosov, Yu. D. Prokoshkin, and Yu. N. Simonov 1967 17 p In RUSSIAN
(JINR-P13-3328)

The characteristics of a threshold Cherenkov counter with a perapex radiator were investigated with the beams of the JINR LNP synchrocyclotron by using a high speed five-beam oscilloscope.
Author (NSA)

N67-38914# Kiel Univ. (West Germany).
THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL PART III: DETERMINATION OF ARRIVAL DIRECTION OF EAS [DAS KIELER LUFTSCHAUEREXPERIMENT. TEIL III: DIE BESTIMMUNG DER EINFALLSWINKEL GROSSER LUFTSCHAUER]
R. Fritze May 1967 63 p refs In GERMAN
(BMwF-FBK-67-40)

The fast timing equipment used for the determination of arrival directions of extensive air showers is described. The delays between two counters are measured by time-to-amplitude converters working on the overlapping principle. The resulting amplitudes are digitized and typed and punched along with the outer air shower data by a teleprinter. The resolution of timing is 1 nsec at particle densities above $10/m^2$. This leads to an error of zenith angle of $1.5°/\cos\theta$.
Author (NSA)

N67-38919*# Harvard School of Public Health, Boston, Mass.
STUDY OF SPACE CABIN ATMOSPHERES Status Report, Jan. 1–Jun. 30, 1967
William A. Burgess and Parker C. Reist 29 Sep. 1967 21 p refs
(Grant NGR-22-007-053)
(NASA-CR-89075) CSCL 14B

Three particle sensors are described: a piezoelectric sensor, an acoustical particle counter, and a heated wire anemometer particle detector. The three sensors were evaluated to determine which had the best potential for automatic monitoring of aerosols in the 1μ to 30μ range. The hot wire anemometer was selected for further development, particularly because of its ability to discriminate between solid and liquid aerosols.
E.C.

N67-38952 Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.

EVALUATION OF A MULTIPLE FM/CW RADIO ALTIMETER INSTALLATION Final Report

Richard W. Cleary Apr. 1967 20 p

(RD-67-21)

Interference effects in multiple radio altimeter installations were investigated. Three FM/CW radio altimeters in one aircraft were operated simultaneously over various types of terrain. Mutual interference between altimeters was not significant under normal operating conditions. Differences of indicated altitude occurred between altimeters over irregular terrain. The differences were pronounced when the antenna patterns of the altimeters were skewed with respect to one another. The differences were not significant when the antenna patterns were approximately coincident. It was recommended that multiple antenna installations be designed to provide nearly coincident beam axes. Author

N67-38970# Israel Program for Scientific Translation, Ltd., Jerusalem.

A GAMMA-SPECTROMETER WITH AN ANTICOINCIDENCE SCINTILLATION SHIELD

N. S. Gusev, Z. M. Ivanova, and I. E. Konstantinov *In its* Dosimetry and Radiation Protect. 1966 p 59–63 refs (See N67-38961 23-24)

A NaI(T1) gamma spectrometer with an anticoincidence scintillator shield is described. The instrument will measure ^{137}Cs activities of the order of 10^{-11} Curies. Author (NSA)

N67-38971# Israel Program for Scientific Translations, Ltd., Jerusalem.

GAMMA-SPECTROMETERS WITH SEMICONDUCTOR DETECTORS

E. L. Stolyarova *In its* Dosimetry and Radiation Protect. 1966 p 64–70 refs (See N67-38961 23-24)

The papers published in the U.S.S.R. and elsewhere on the various aspects of silicon and germanium gamma spectrometers are surveyed. Author (NSA)

N67-38982# Israel Program for Scientific Translations, Ltd., Jerusalem.

AN ESTIMATE OF THE OPTIMAL SIZE OF THE SCINTILLATOR FOR SINGLE-CRYSTAL FAST-NEUTRON SPECTROMETERS

G. G. Doroshenko *In its* Dosimetry and Radiation Protect. 1966 p 111–112 refs (See N67-38961 23-24)

A method for estimating the optimal size of a scintillator for single-crystal fast-neutron spectrometers is described. Author (NSA)

N67-38983# Israel Program for Scientific Translations, Ltd., Jerusalem.

A HIGH-RESPONSE TRANSISTORIZED PULSE-HEIGHT DISCRIMINATOR

V. A. Fedorov and G. G. Doroshenko *In its* Dosimetry and Radiation Protect. 1966 p 113–114 refs (See N67-38961 23-24)

A transistorized pulse height discriminator with a threshold of nearly 5 mV and a recovery time of 0.1 μsec. is described. Author (NSA)

N67-38984# Israel Program for Scientific Translations, Ltd., Jerusalem.

A STABILIZATION CIRCUIT FOR THE AMPLIFIER CHANNEL OF A FAST-NEUTRON SPECTROMETER

G. G. Doroshenko, V. A. Fedorov, and E. S. Leonov *In its* Dosimetry and Radiation Protect. 1966 p 115–117 refs (See N67-38961 23-24)

A stabilization circuit for the amplifier channel of a fast neutron spectrometer is described. The circuit was designed in order to obtain high stability and precision in the instrumental spectrum. NSA

N67-39004 Joint Publications Research Service, Washington, D. C.

CONDITIONS OF MAXIMUM RESPONSE OF A MAGNETOMETER BASED ON THE OPTICAL ORIENTATION OF ATOMS

G. P. Nedobodiyev and V. M. Ryzhkov 9 Oct. 1967 5 p refs Transl. into ENGLISH from Geofizicheskaya Apparatura (Leningrad), no. 26, 1965 p 26–28

(JPRS-42895; TT-67-33521) CFSTI: $3.00

A mathematical discussion is presented on the response in magnetometers with a longitudinal ray. The response to change of the magnetic field is dependent on the amplitude of the radiofrequency field and the modulation amplitude for a given intensity of the light source. An expression is developed for the dependence of the amplitude of the first harmonic signal on the frequency difference for different parametric values, and the results are graphed. N.E.N.

N67-39048# Japan Atomic Energy Research Inst., Tokyo.

THE NEUTRON TIME-OF-FLIGHT SPECTROMETER AT JAERI LINAC

A. Asami, T. Fuketa, Y. Kawarasaki, Y. Nakajima, M. Okubo et al Aug. 1967 21 p refs

(JAERI-1138) CFSTI: HC$3.00/MF$0.65

The physical arrangements and characteristics of the neutron time of flight spectrometer installation are described. A pulsed neutron beam is produced at a photoneutron target by the linac electron pulses, with widths of any value from 4 μsec to 40 nsec. The neutrons are detected through evacuated flight tubes using a neutron detector composed of ^{6}Li-glass scintillators at 50 meters from the source target. The flight time of neutrons between the target and the detector is measured by a 4096-channel time analyzer. Characteristics of the neutron detector, spectrum of the neutron beam, background, resolution, monitoring of the neutron beam, data processing, and typical data of the neutron transmission are also reported. Author

N67-39120 Joint Publications Research Service, Washington, D. C.

CONDITIONS OF MAXIMUM SENSITIVITY OF A MAGNETOMETER BASED ON OPTICAL ORIENTATION OF THE ATOMS

G. P. Nedovodiyev and V. M. Ryzhkov 22 Sep. 1967 5 p refs Transl. into ENGLISH from Geofizicheskaya Apparatura (Leningrad), no. 26, 1965 p 26–28

(JPRS-42727; TT-67-33354) CFSTI: $3.00

An expression derived for a signal obtained in a photodetector was applied to determining the relationship of the amplitude of the first harmonic of certain signals in a magnetometer for various parametric values. According to the equation, the sensitivity of the magnetometer to a variation in the magnetic field will increase with steepness in the variation of the amplitude of the first harmonic in the center of resonance $x = 0$. L.S.

N67-39141# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.

THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL. PART VII: STUDIES ON A SONIC SPARK CHAMBER [DAS KIELER LUFTSCHAUER-EXPERIMENT. TEIL VII. UNTERSUCHUNGEN AN EINER AKUSTISCHEN FUNKENKAMMER]

H. G. Priesmeyer May 1967 33 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-44)

The acoustical method to determine spark positions is tested in an air-filled spark chamber of 1 m × 1 m size. With the 1-m-long piezoelectric microphone the resolution in the spark position is ≤0.5 mm. Even for great spark distances R the output signal U_p of the microphone is well above the noise level ($U_p \approx R^{-1/2} \exp(-\beta R)$). Measurements on the influence of the supersonic region independence from spark voltage, spark length, and distance from spark to microphone are discussed. Author (NSA)

N67-39142# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL PART VIII: CLOUD CHAMBER STUDIES OF EAS [DAS KIELER LUFTSCHAUER EXPERIMENT. TEIL VIII. NEBELKAMMERMESSUNGEN AN LUFTSCHAUERN
W. Wolter May 1967 26 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-45)

For testing the apparatus of the air shower experiment at Kiel a preliminary experiment was installed containing a small cloud chamber. The transistorized electronics for operating the cloud chamber is described. To study the stereoscopic cloud chamber photographs a simple reprojection system was used. The angular distribution of the air shower particles was analyzed. Author (NSA)

N67-39197# Sandia Corp., Albuquerque, N. Mex.
[INSTRUMENTATION FOR ATMOSPHERIC DENSITY AND COMPOSITION MEASUREMENTS ABOVE 100 KILOMETERS]
R. O. Woods Jun. 1967 20 p refs Presented at the Am. Astronautical Soc. Symp., Denver
(Contract AT(29-1)-789)
(SC-DC-67-1901; CONF-670710-2) CFSTI: HC $3.00/MF $0.65

A system is described for making density measurements in the atmosphere between 100 and 300 kilometers. Since the vehicle flight environment strongly influences densimeter (vacuum gage) design and the mode operation of the gage establishes criteria for the vehicle motion, then the design of the experiment involves a consideration of the system as a whole. This consideration is discussed with particular reference to the Nike–Tomahawk vehicle. Instruments used in earlier experiments are described, along with a discussion of the present generation of commercial gages and the modifications which are being made to enable them to meet the environmental conditions. A discussion of existing types of mass spectrometers and the relative merits of each for rocket applications is presented. The problem of providing a suitable ion source is also discussed. NSA

N67-39205*# GCA Technology Div., GCA Corp., Bedford, Mass.
MASS SPECTROMETER ANALYSIS OF SOLID MATERIALS WITH THE ION-MICROPROBE SPUTTER SOURCE Final Report
R. F. K. Herzog, W. P. Poschenrieder, and F. G. Satkiewicz Feb. 1967 68 p refs
(Contract NAS5-9254)
(NASA-CR-89326; GCA-TR-67-3-N) CSCL 20F

The sputter ion source mass spectrometer has proven to be a valuable analytical tool. The present report describes a number of instrumental improvements, explains an important discovery about the initial energy distribution of the sputtered ions, and particularly deals with geological applications of the instrument. Author

N67-39218# Sandia Corp., Albuquerque, N. Mex.
SHOCK-WAVE STRESS GAUGE UTILIZING THE CAPACITANCE CHANGE OF A SOLID DIELECTRIC DISC
R. A. Graham and G. E. Ingram Jun. 1967 15 p refs Presented at the Intern. Symp. on the Behavior of Dense Media under High Impulsive Pressures, Paris, 11–15 Sep. 1967
(Contract AT(29-1)-789)
(SC-DC-67-1910; CONF-670914-8) CFSTI: HC $3.00/MF $0.65

A new type of gage is described which is capable of measuring either particle velocity or stress with time resolution limited only by the rise time of the recording equipment and the planarity of the shock-wave front. The signal from the gage results from the capacitance change of a solid dielectric disc which produces a current which is instantaneously proportional to the velocity of the stressed electrode. NSA

N67-39257 Southampton Univ. (England). Inst. of Sound and Vibration Research.
OPERATION OF THE CONSTANT RESISTANCE HOT-WIRE ANEMOMETER
P. O. A. L. Davies, M. R. Davis, and I. Wold [1967] 50 p refs
(ISAV-189)

This report gives practical details of constant temperature hot wire anemometer operation and performance, with some emphasis on the techniques developed at Southampton. It also includes details of hot wire probe construction for optimum performance. Author

N67-39266# Denver Univ., Colo. Dept. of Physics.
INSTRUMENTATION FOR BALLOON-BORNE INFRARED SPECTRAL MEASUREMENTS
David G. Murcray, Frank H. Murcray, and Walter J. Williams *In* AFRCL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 49–57 ref (See N67-39261 23-02)

Instrumentation was developed for obtaining high resolution infrared spectra from a balloon platform as it ascends through the atmosphere. These measurements were made possible by the development of low noise, low frequency, time and temperature stable electronics, optically stable spectrometers and spectral radiometers, accurate solar pointing, and on-board digital magnetic tape recording. Using this instrumentation high resolution spectra were obtained at a multitude of altitudes on ten balloon flights made from three geographic locations. The instrumentation is described, with particular emphasis on problems associated with the ballon environment and the performance of the individual components evaluated. Author

N67-39271# Air Force Cambridge Research Labs., Bedford, Mass.
A NEW PRESSURE SENSOR FOR HIGH-ALTITUDE BALLOONS
Walter C. Wagner *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 117–123 (See N67-39261 23-02)

Details are presented on the indirect gauge which measures the heat transfer across an air gap with thermistors. Circuit diagrams are included for the resistance and voltage outputs and for the Morse code generator. The chief errors are identified as drift errors, and all can be kept sufficiently low except for changes due to air composition and the accommodation coefficient of the tube and inner bead. N.E.N.

N67-39278# Air Force Cambridge Research Labs., Bedford, Mass.
BALLOON-BORNE INSTRUMENTATION
Chester G. R. Czejyha *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 151–160 (See N67-39261 23-02)

A few of the more important recent developments in the field of balloon instrumentation for command and control and safety of flight are presented. Included are discussions of recent flight results of both the UHF communications relay on a balloon carrier in the Holloman Air Force Base area and the prototype VHF-HF omnidirectional balloon locating system carried aboard long duration/distance flights from Chico, California. A further area of significant interest will be a discussion of lightweight and economical radar reflectors for attachment to balloons to insure a sufficient target cross-sectional area for adequate radar balloon tracking at all times. Author

N67-39276# Vitro Labs., Silver Spring, Md.
PROBLEMS ENCOUNTERED IN THE DEVELOPMENT OF THE STRATOSCOPE II FLIGHT SYSTEM
G. C. Ellerton, Jr. and J. P. Jackson *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 161–175 (See N67-39261 23-02)

The balloon development phase began in the fall of 1960. At that time, the design of the telescope was, for all practical purposes, complete and fabrication was in progress. Flight system requirements were established with certain limitations imposed by the instrument design. It was immediately obvious that Stratoscope II requirements were pushing the state-of-the-art in ballooning and that some pioneering in the development of heavy-load high-altitude technique would be necessary. The principle problems encountered during the balloon development phase were related to and grew out of the sensitivity of the Stratoscope II telescope to ground handling, launching and recovery shocks; the requirement for a night flight; the unprecedented weight of the payload; the need for a reasonable standby time when the system was flight ready; and, the need for a single all-year-round launching site. Problems were approached and solved during a period of analysis, design, fabrication, laboratory and actual full-scale field tests culminating in a fully instrumented scientific flight in March of 1963. Author

N67-39277# Air Force Cambridge Research Labs., Bedford, Mass.
IN-FLIGHT DEPLOYMENT OF LONG-TRAIN INSTRUMENTATION PACKAGES FROM HIGH-ALTITUDE BALLOONS
R. J. Reddy *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 177–183 refs (See N67-39261 23-02)

Techniques for the precise positioning and in-flight deployment of instrumentation canisters along a balloon-borne train were expanded and refined. Several flight configurations were developed and tested incorporating payloads ranging from 760 to 4500 lb, with 6 or 7 instrumentation canisters weighing from 50 to 325 lb, and placed along trains between 2350 and 3500 ft in length. Emphasis was placed on tube parachute design and the connecting line between canisters. Devices are mentioned which were designed and fabricated to aid or to produce a more rapid parachute opening. The fluid brake reel, consisting of a series of brake disks working against a braking fluid, is briefly described. The characteristics of the coreless nylon braid train connecting line are given. It is felt that the test programs have led to the development of a unique in-flight method for deploying canisters. N.E.N.

N67-39281# Air Force Cambridge Research Labs., Bedford, Mass.
THE BALLOON BORNE OPTICAL BEACON: A USEFUL GEODETIC SYSTEM FOR PURPOSES OF DENSIFICATION
Jack A. Cook and Michael S. Taverner *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 233–238 refs (See N67-39261 23-02)

The technical problems, operational procedures, and flight test results for the optical beacon are reported. Methods of aiming the cameras at the optical beacon are briefly discussed, and the results of photographic analysis are outlined. It was concluded that the optical beacon performed well and that its use in geodetic surveying is feasible. It was further determined that it can be used also for measuring wind shifts and characteristics at high altitudes, tracking and positioning of balloon flights, rapid post-mission analysis of precise positioning of experimental payloads, and measuring velocity vectors by 2-station ties. N.E.N.

N67-39308# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL PART V: NEON HODOSCOPE [DAS KIELER LUFTSCHAUER EXPERIMENT. TEIL V. DAS NEONHODOSKOP]
M. Samorski May 1967 65 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-42)

A detailed description of the features and construction of a 32-m^2 neon hodoscope is given, operating in an extensive air shower experiment at Kiel since June 1965. The hodoscope is used to examine the fine structure of air shower cores. The different forms of air shower cores so far detected are reviewed. The methods of scanning neon hodoscope pictures and of data processing are discussed in connection with the physical aims of the experiment. First preliminary results are compared with those of other air shower groups. Author (NSA)

N67-39371# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
HIGH RIGIDITY LOAD CELLS FOR FORCES BETWEEN 1,000 AND 50,000 daN [DYNAMOMETRES DE GRANDE RIGIDITE CAPACITE DE 1,000 A 50,000 daN]
Roger Helou 1967 15 p refs In FRENCH; ENGLISH summary
(ONERA-TN-109(1967))

The design, construction, and calibration of two types of load cells is described. The first type belongs to the series 20N91 to 20N97 for loads from 1,000 to 50,000 daN; it is very rigid axially and laterally. These load cells are verified in vacuum and not affected by lateral loads; they are not sensitive to temperature effects and their precision is ±1/1,000. They may be used with or without mono- or universal flexures on several-component load-cell rigs. The second type, 20N100, is very rigid axially and gives an important signal because of the use of semiconductor strain-gages. Author

N67-39380# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
THE EXTENSIVE AIR SHOWER EXPERIMENT AT KIEL PART IV: DIGITAL DATA RECORDING SYSTEM [DAS KIELER LUFTSCHAUER-EXPERIMENT. TEIL IV. DIE ELEKTRONISCHE DATENAUSGABE]
U. J. Roose May 1967 21 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-41)

Electronic equipment for simultaneous operation of 16 scintillation counters, a Cherenkov counter, a 32-m^2 neon hodoscope, and a μ-meson spectrometer is described. The arrangement and functioning of the detectors is discussed and the automatic electronic recording system for preparation and readout of data by a teleprinter and on paper tape is explained. Author (NSA)

15 MACHINE ELEMENTS AND PROCESSES

Includes bearings, seals, pumps, and other mechanical equipment; lubrication, friction, and wear; manufacturing processes and quality control, and reliability; drafting; and materials fabrication, handling, and inspection.

N67-38115# Mechanical Technology, Inc., Latham, N. Y.
REVIEW OF FAILURE MECHANISMS IN HIGHLY LOADED ROLLING AND SLIDING CONTACTS
A. J. Smalley, S. F. Murray, H. Christensen, and H. S. Cheng May 1967 70 p refs
(Contract N00014-66-0-0037)
(MTI-67TR23; AD-657337)

The failure modes of fatigue and scoring in highly loaded contacts are analyzed. Existing theories by which their onset may be predicted are critically examined, and the relationship between these failure modes and the phenomenon of elastohydrodynamic lubrication is shown. The possible modifying influence of microelastohydrodynamic occurrences is pointed out and a method of analyzing such occurrences is proposed. The protecting influence of boundary lubrication effects is also demonstrated, and mechanisms for satisfactory performance and failure under the influence of this phenomenon are put forward. Author (TAB)

N67-38117# RAND Corp., Santa Monica, Calif.
OPTIMUM MAINTENANCE WITH INCOMPLETE INFORMATION
James E. Eckles Aug. 1967 29 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5390-PR; AD-657010)

An analysis of the maintenance of systems with randomly decreasing performance levels that can be estimated only by costly imperfect inspection. A model is developed to determine the sequence of actions that minimizes the total cost of operation. Unlike most investigations, the study treats maintenance as a sequential decision process. This view leads to the consideration of maintenance policies in which corrective and inspection schedules are dependent on the results of recent inspections. A dynamic-programming technique is used to derive a functional equation for the optimum maintenance policy. It is shown that an optimum action (replacement, repair, inspection, etc.) is determined by the systems age and the posterior distribution over the systems states. Simple policies such as periodic inspection are readily seen to be nonoptimal in the face of irregular deterioration. Author (TAB)

N67-38134# Picatinny Arsenal, Dover, N. J. Ammunition Engineering Directorate.
A COMPUTER PROGRAM TO DETERMINE ACCEPTANCE CRITERIA AND THE OPERATING CHARACTERISTIC CURVE WHEN SAMPLING VARIABLES (QUALITY CONTROL)
Donald C. Rappaport Jul. 1967 22 p ref
(PA-TR-3584; AD-655849)

A variable plan for acceptance inspection is based upon the sample mean and the sample standard deviation. This program computes a value K, such that the sample mean plus K times the sample standard deviation will indicate the acceptability of a lot. If the specified upper limit is exceeded, the lot is not acceptable. This program will compute K from a given sample size and one point on the operating characteristic curve, or will compute K and the sample size from two points on the operating characteristics curve and will then draw the operating characteristics curve. TAB

N67-38189# General Precision, Inc., Little Falls, N. J. Aerospace Group.
STUDY OF MICROMECHANICAL PROPERTIES OF ADHESIVE BONDED JOINTS Bimonthly Progress Report, 1 May-30 Jun. 1967
John L. Rutherford and Edward J. Hughes Dover, N. J., Picatinny Arsenal, 18 Jul. 1967 33 p
(Contract DAAA21-67-C-0500)
(PA-TR-3591; BMPR-3; AD-655850)

The objective of the program is to demonstrate the feasibility of using a microstrain technique for measuring the mechanical properties of epoxy adhesives in thin film joints in tension, compression and shear. The report includes a summary of the progress during the first four months of this contract. During the current report period, the principal effort was devoted to the shear tests; the following accomplishments were achieved: To account for friction losses in the loading chain sprockets, a new load cell had to be built and mounted next to the torsion sprocket; The correction factor accounting for deformation in the adherends was established; The shear modulus for the principal epoxy system was found to be 388,000 plus or minus 30,000 psi; The material deformed elastically, with no evidence of visco-elasticity prior to fracture; Fracture stresses varied from 5600 to 7180 psi; The fracture was principally adhesive and was characterized by cracks in the epoxy. The results obtained to date represent a significant advance in the techniques available for measuring deformation characteristics of adhesives in actual joints. Such results should be extremely useful for an understanding of the mechanical behavior of adhesives. Author (TAB)

N67-38170# Ogden Air Materiel Area, Hill AFB, Utah.
EVALUATION OF IMPROVED T-39 BRAKE, GOODYEAR P/N 9550338 Final Report
William H. Olsen Jul. 1966 30 p
(AD-657385)

OONR reported the T-39 organic brake, P/N 9541626, wear life of 35-40 landings was unsatisfactory. OONER proposed an improved design tri-metallic brake, P/N 9550338, for the T-39. To allow early evaluation, prototypes of the proposed brakes were utilized to obtain an estimation of service life improvement. The prototype brake, P/N 5E5-124, lasted for 486 landings, before the wearout limit was obtained. Two production brakes P/N 9550338 were then available. The production brakes were tested and 517 landings were obtained before removal for wear. Author (TAB)

N67-38399# Monsanto Research Corp., Dayton, Ohio.
DEVELOPMENT OF AN INJECTION MOLDING PROCESS FOR PRESS PARTS Final Report, 1 Jul.-31 Dec. 1966
Ival O. Salyer, George L. Ball, III, and William E. Welch Jan. 1967 18 p Prepared for California Univ., Livermore
(Contract W-7405-ENG-48)
(UCRL-13280) CFSTI: HC$3.00/MF$0.65

Sled retraction, intrusion molding, and decompression features were added to the HPM 450-IX-20 screw type injection molding machine. These features allow the molding of parts of greater size than the 20-oz capacity of the machine and provide for better control of the plastic prior to injection. A multi-circuit steam manifold was designed, constructed, and installed for operation with the HPM-IX-20 screw type injection molding machine. The manifold provides eight solenoid-activated, independently controlled steam-heating and cooling lines required for the press part die. The color stability of Merlon M-80, 9950 green, transparent polycarbonate in the visual region was shown to be adequate to be used for visual identification of parts by color. Difficulties were encountered in molding the green, transparent Merlon M-80 polycarbonate, causing high torque values and increased screw-return times. Solution and melt viscosity data did not indicate significant rheological differences between the newer, green Merlon M-80 and an older clear batch purchased during the first quarter of 1966. However, the melt viscosity of Lexan 131 polycarbonate was significantly lower than that of either lot of the Merlon M-80. A knuckle gage was installed, calibrated, and made ready for operation. Author (NSA)

N67-38449# Union Carbide Nuclear Co., Oak Ridge, Tenn. Y-12 Plant.
SOME AOQ AND AFI VALUES FOR THE DODGE AND TORREY CSP-3 CONTINUOUS SAMPLING PLAN
R. H. Hull, Jr. 7 Jul. 1967 176 p refs
(Contract W-7405-ENG-26)
(Y-1585)

The purposes of this study were to present a mathematical proof of the AOQ formula for the continuous sampling plan, CSP-3, and to apply this formula in deriving AOQ and AFI values for CSP-3. Because of the complexity of the AOQ formula and time consuming calculations involved, a computer program was written to determine AOQ and AFI values. For each set of values generated, the per cent defective, p, ranged from 0.5 per cent to 50.0 per cent at increments of 0.5 per cent. The values of i used in this study ranged from 5 to 200 units, and the sampling rate, f, began with 5 per cent and terminated with 50 per cent at increments of 5 per cent. An assumption was made that i=k. The computer program was written in such a manner that AOQ and AFI values could be generated for a given i value at various levels of f and p with only one data card. Therefore, AOQ and AFI values other than those appearing in this study may be generated with this computer program. Curves for obtaining values of f and i for a given value of AOQL were determined. When compared to the corresponding CSP-2 values, an examination revealed that the i values for CSP-3 were reduced by about 4 units when AOQL is 2 per cent; at 3 per cent AOQL, the CSP-3 i values were about 3 units less than the CSP-2 values; and for AOQL values greater than 3 per cent, the i values for CSP-3 were about 2 units less than the CSP-2 values. Author (NSA)

N67-38490 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF STEEL PAN TRUNNIONS IN COSIPA'S STEEL PLANT [INSPECAO ULTRA-SONICA DOS MUNHOES DAS PANELAS DE ACO DA ACIACIA DA COSIPA-PIACAGUERA]
L. X. Nepomuceno, M. F. Barbosa, and W. Visentini 6 Oct. 1966 39 p refs In PORTUGUESE
(Rept.-6609.272)

Equipment, methods, and results of an ultrasonic inspection of steel plant trunnions are presented. The results are given in tables, charts, and photographs. Author

N67-38697*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
EXPERIMENTAL INVESTIGATION OF THE EFFECT OF MODEL SCALE ON STRUCTURAL-JOINT DAMPING
David G. Stephens, Brantley R. Hanks, and Maurice A. Scavullo Washington, NASA, Oct. 1967 24 p refs
(NASA-TN-D-4192) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An investigation was conducted to determine the effect of model scale or size on structural-joint damping. A cantilever configuration was utilized wherein the beam was bolted between two angle brackets at the support. Four geometrically similar assemblies, covering a scale range of approximately 20 to 1, were tested. Free decay of the fundamental mode was measured over a range of joint clamping pressures and beam-tip amplitudes. Also, damping results from the addition of liquid lubricants or plastic films to the joint interfaces was investigated. Data indicate that a decrease in model size results in an increase in the damping attributed to the structural joint. Furthermore, the magnitude of the joint damping is slightly dependent on vibration amplitude and is an inverse function of joint clamping pressure. Structural-joint damping may be substantially increased by the addition of liquid lubricants or plastic films to the joint interfaces. Author

N67-38806# Oak Ridge National Lab., Tenn.
APPLICATION OF CHEMICAL VAPOR DEPOSITION TO THE PRODUCTION OF TUNGSTEN TUBING
W. R. Martin, R. L. Heestand, R. E. McDonald, and G. A. Reimann [1967] 25 p ref Presented at the Conf. on Chem. Vapor Deposition of Refractory Metals, Gatlinburgh, Tenn.
(Contract W-7405-ENG-26)
(ORNL-P-3102; CONF-670905-3) CFSTI: HC $3.00/MF $0.65

The direct process of chemical vapor deposition for producing tungsten tubes for further working or tubing in its final form is discussed. The as-deposited structure of the chemical vapor-deposited W may be sufficient and/or desirable for some specific applications. Simple shapes such as tubing in lengths up to nearly 4 ft can be made easily and are less expensive than equivalent tubing made by the conventional extrusion–drawing method. Such tubes can be made in various dia with wall thickness variations not exceeding ±0.001 in. in the as-deposited condition. Therefore, this method is attractive for making shorter lengths of tubing of higher purity (less than 25 ppM total metallic impurities). If the as-deposited structure of chemical vapor-deposited W is undesirable, tube shells for further working can be made by chemical vapor deposition. These tube shells can be worked conventionally, as by extrusion and drawing. The microstructure of chemical vapor-deposited material after working is comparable to that of arc-cast or powder-metallurgy products. If the amount of drawing is reduced to a few passes, the cost of worked chemical vapor-deposited tubing would be less than that of conventional tungsten tubing. Author (NSA)

N67-38858# United Kingdom Atomic Energy Authority, Culham (England). Culham Lab.
FAST-ACTING STRIP ELECTRODYNAMIC VALVE FOR PERIPHERAL GAS ADMISSION
N. V. Filippov, L. G. Golubchikov, and V. D. Ivanov Mar. 1967 15 p refs Transl. into ENGLISH from IAE-1116 Report
(IAE-1116; NP-TR-1536; CTO-375) CFSTI: HC $3.00/MF $0.65

The characteristics of an electrodynamic valve suitable for rapidly producing a fairly large annular gas blob are investigated experimentally and theoretically. Considerable homogeneity and symmetry of this blob can be obtained. The valve-open time can be adjusted between 20 and 70 μsec during which up to 1 cm^3 of air at atmospheric pressure can be admitted. Methods for improving the valve operating speed are discussed. Author (NSA)

N67-38700*# Battelle Memorial Inst., Columbus, Ohio.
STUDY OF ROLLING-CONTACT PHENOMENA IN MAGNESIUM OXIDE Summary Report No. 1
K. F. Dufrane and W. A. Glaeser 25 Sep. 1967 37 p refs
(Contract NAS3-6263)
(NASA-CR-72295) CFSTI: HC $3.00/MF $0.65 CSCL 13I

The phenomena associated with rolling contact deformation was studied using steel balls rolling on MgO single crystals. The depth of slip was found to be velocity dependent in the [100] rolling direction. Fatigue spalls similar to those found in actual bearings were produced after extended numbers of rolling cycles. Addition of lubricant to the surface changed the slip mode and caused premature spalling. Actual dislocation arrays in the deformed track regions were observed by thin film transmission electron microscopy. Author

N67-38769# Princeton, Univ., N. J. Plasma Physics Lab.
MANUFACTURING TECHNIQUES USED IN FABRICATION OF HELICAL, SEMITOROIDAL ELECTRICAL WINDINGS
J. B. Joyce *In its* Plasma Phys. Lab. May 1967 p 370–378
(See N67-38725 23-25)

Manufacturing details for electrical stabilizing windings are reviewed in regard to their ability to provide magnetic shear for

C stellarator plasma containers. Size and shape of the conductors were determined after completion of magnetical designs for conductor shapes and the coil systems. Support systems were evaluated for their advantages and it was found that internal tube and glass-epoxy rings provided good external and internal support with continuity. Location of conductors in the winding was subject to machining and assembly tolerances. Evaluation tests showed that both inner and outer support structures were required and that a continuous support must span from end to end of the winding.
G.G.

N67-38810 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF SPECIAL STEEL PLATES ACCORDING TO ASTM A-435/59T AND VDE 072/57 [INSPECAO ULTRA-SONICA DE CHAPAS DE ACO ESPECIAL, DE CONFORMIDADE COM ASTM A-435/59T E VDE 072/57
L. X. Nepomuceno, W. Visentini, and M. F. Barboza 14 Dec. 1966 3 p In PORTUGUESE
(Rept.-6612.277)

Results are presented for the ultrasonic inspection of two steel plates, whose dimensions were 1.200×7.750×1-1/2" and 1.200×4.750×1-1/2". Procedures and equipment are briefly noted for the inspection, which was done according to ASTM A-435/59T and VDE 072/57. Transl. by M.W.R.

N67-38858# General Dynamics/Convair, San Diego, Calif.
FORMABILITY AND WELDING OF THIN GAGE LIGHTWEIGHT ALLOYS
S. R. Carpenter Dec. 1966 74 p refs
(GD/C-ERR-AN-1067)

The Be38A1 sheet was examined for (1) consistency of the mill product, (2) methods to improve the bend angle and bend radius, (3) effects of tensile forming strains at 400°F on the mechanical properties, (4) diffusion bonding parameters using differential thermal expansion tooling and rolling processes, (5) parting materials to release the workpiece from tooling after diffusion bonding, (6) brazing processes, (7) metal cutting, and rivet edge distance. Investigations were conducted to diffusion bond beryllium with and without interface materials and to clad beryllium with nickel and vanadium. Test procedures are described and results are presented by tables, graphs, and discussion. Author

N67-38886# California Univ., Livermore. Lawrence Radiation Lab.
EFFECT OF FIRE INTRUSION AND HEAT ON HEPA FILTER UNITS
Jack L. Murrow *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 96-108 (See N67-38880 23-22)

Special equipment has been developed for the dynamic testing of 1000-cfm high-efficiency particulate air filters by fire intrusion or high temperature. USNRL-type mechanical dioctyl phthalate generator and photometer systems are used to determine "before" and "after" filter efficiencies. The degree of protection of the HEPA filter from fire is almost directly related to the heat-absorbing capacity of the prefilter. Three new sealing materials have successfully passed hot gas tests. Particle board treated for fire retardance by the pressure-soak method has been accepted as framing material. Particle board having the fire-retardant material mixed in before pressing also shows promise as framing material, and is less expensive than particle board or plywood treated by soaking. Author (NSA)

N67-38887# Hanford Occupational Health Foundation, Richland, Wash.
FACTORS INFLUENCING HIGH-EFFICIENCY GASKET LEAKAGE
F. E. Adley *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 109-148 refs (See N67-38880 23-22)
(Contract AT(45-1)-1837)

Tests were performed to develop data which would demonstrate factors related to gasket leakage that warrant more detailed study. The effect of time on installed gaskets was shown by conducting tests to simulate and measure the effect of various mounting forces on leakage over a period of several weeks. The change in compression due to dynamic loading was demonstrated for a cellular and solid gasket over a period of 20 days. Leakage from inadequately cemented gasket joints was significantly greater than from those well-prepared, but moderate clamping pressures reduced joint leakage, particularly with solid elastomers. High compression of the gaskets studied was found unnecessary to reduce leakage to levels well below the lower limit of sensitivity of the thermal dioctyl phthalate (DOP) filter testing method. Tests on solid molded gaskets of the same hardness in nine different shapes showed measurable differences in sealing quality. Gasket hardness failed to show any relationship to sealing quality nor was there any definite advantage between solid and cellular elastomers.
NSA

N67-38915# Roentgen Technische Dienst N. V., Rotterdam (Netherlands).
NON-DESTRUCTIVE EXAMINATION OF WELDS
20 Apr. 1967 79 p
(Contract EURATOM-045-61-5 RDH)
(EURAEC-1859; EUR-3364; FR-1) CFSTI: HC$3.00/MF$0.65

The aspects of nondestructive examination of welds in steel thicknesses up to 300 mm were investigated. For radiographic tests the optimum exposure conditions were defined, taking into account different types of radiographic films and the use of a variety of screens. Once the optimum exposure conditions were established an extra set of radiographs was made with a density of ≈3, to compare the qualities of the radiographs obtained with the different sources of radiation. In comparison of the radiographs both the appearance of image quality indicators and inhomogeneities (cracks, slag, pores, and drilled holes) were incorporated. There is no great difference between the quality of the different films. The dominant factor in the decrease of discernibility of inhomogeneities was the increase of thickness when the optimum exposure conditions could be met. The rather drastic loss in flaw visibility observed with increasing thickness from 30 to 100 mm was not observed for a thickness increase from 100 to 300 mm. For ultrasonic examination, different scanning techniques were tried. With the thickness involved and the type of weld defects one probe was insufficient. A probe angle of 45° seemed most appropriate. NSA

N67-38918# Atomic Energy Commission Research Establishment, Riso (Denmark).
DIGITAL POSITIONING SYSTEM OF THE SLEWING AND INCHING TYPE
K. E. Neisig Sep. 1966 28 p refs
(RISO-143)

A control system is described for the digital setting of a mechanical shaft to a given position. The system uses a shaft digitizer and a step motor. To avoid dead zone inaccuracy the positioning takes place always from the same side and to avoid overshoot from inertia the last part of the motion takes place at low speed. NSA

N67-38992# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
A BIBLIOGRAPHY OF ALUMINUM–NICKEL–URANIUM BONDING
W. E. Gurwell 21 Apr. 1967 23 p refs
(Contract AT(45-1)-1830)
(BNWL-CC-1185) CFSTI: HC $3.00/MF $0.65

This bibliography of 135 references resulted from a search of published literature pertinent to the atomic energy field and was based on Abstracts of Classified Reports, 1953 to April 1967 and Nuclear Science Abstracts, 1951 to April 1967. Only major contributions are included. Some entries are followed by a brief summary to indicate the type or scope of work and any significant results. The references are divided into 6 sections: bonding processes, nickel plates on uranium, bond characteristics and evaluation, Al–Ni diffusion, Ni–U diffusion, and Al–Ni–U and general diffusion. NSA

N67-38993# National Engineering Lab., Glascow (Scotland).
FATIGUE STRENGTH OF SHAFTS WITH SHRUNK-ON RINGS
J. D. McAllan Dec. 1966 41 p refs
(NEL-259)

Experimental details and results are presented for an investigation into the fatigue strength of plain shafts having rings shrunk on to them adjacent to shaft stress raisers. Assemblies with one or two shrink fits have been considered and compared with solid specimens of the same outline dimensions. The assembly having two shrink fits, one on either side of a stress raiser, was found to cause the greatest reduction in shaft fatigue limit. The geometrical effect was the most significant, the fatigue limits of the assemblies approximating roughly to those of the corresponding integral forms. Author

N67-39023# Southwest Research Inst., San Antonio, Tex. Dept. of Aerospace Propulsion Research.
FUNDAMENTAL INVESTIGATION OF LIQUID-METAL LUBRICATED JOURNAL BEARINGS Final Report
R. A. Burton and Y. C. Hsu 20 Jun. 1967 245 p refs
(Contract AT(11-1)-1228)
(RS-502; SWRI-1228P8-33) CFSTI: HC $3.00/MF $0.65

Results of an analytical and experimental research are presented on turbulent-film bearings applicable to short bearings with predominant end leakage, long tilted pads with predominant end leakage, long tilted pads with approximately tangential flow, and finite tilted pads. The problems of the turbulent squeeze film, when there is a relative velocity in the direction normal to the surface, and of the free surface with surface-tension effects are covered. Inertial effects and examples for solving the film equations are given. An annular-flow apparatus is described which is used to simulate conditions encountered by bearings in turbulent film flow. Equations are derived for thin lubricant films with end leakage and infinitely long turbulent squeeze films. Short journal bearings, bearings without end leakage, and tilted pads were analyzed. Basic equations for turbulent thin liquid films in the presence of surface tension are given. NSA

N67-39024# Union Carbide Corp., Oak Ridge, Tenn. Nuclear Div.
PREPARATION OF CERAMIC URANIUM DIOXIDE COMPACTS
P. E. Trent 5 Jul. 1967 19 p ref Presented at the Am. Ceram. Soc. Meeting, Gatlinburg, Tenn., 8–10 Jun. 1967
(Contract W-7405-ENG-26)
(Y-DA-1733; CONF-670626-1) CFSTI: HC $3.00/MF $0.65

Experience in the fabrication of high density UO_2 compacts from a ceramic-grade UO_2 powder without the use of binders and lubricants and without the necessity for high-pressure pressing equipment is described. The pellets are crack free and have sharp edges and smooth surfaces without any chips. Sufficient experience was gained to make it possible to fill future orders for pellets that would have densities as low as 8.0 g/cc. NSA

N67-39138# Los Alamos Scientific Lab., N. Mex.
CRYOGENIC VALVE TESTING
Evan R. Johnson [1967] 7 p 22nd Instr.–Automation Conf. and Exhibit, Chicago
(Contract W-7405-ENG-36)
(LA-DC-8846; CONF-670903-5) CFSTI: HC $3.00/MF $0.65

The results of testing cryogenic valves in the nuclear rocket development program are presented. This program uses cryogenic valves in sizes up to 16", with working pressures to 2160 psig, and temperatures as low as −423°F. Author (NSA)

N67-39165*# Ampex Corp., Redwood City, Calif.
STUDY OF TIRES ON A WET RUNWAY Final Report, 24 May 1966–24 Sep. 1967
A. Eshel Sep. 1967 109 p refs
(Contract NASw-1408)
(NASA-CR-89324; RR-67-24) CSCL 13F

A foundation to the theory of hydroplaning is laid and solutions to simplified models are obtained. Hydrodynamics, tire elasticity, and the coupling between them are considered. The hydrodynamic problem is broken into three regions: inlet, center, and exit. Approximate equations for the central region, including the effects of viscosity, fluid inertia, and side flow, are derived. Approximate boundary conditions for the inlet and exit are presented, and a break-up into simpler subproblems is made. Several tire elastic models of varying degrees of complexity are studied. Selected problems are numerically attacked and the results are graphically presented. Author

N67-39194# Sandia Corp., Livermore, Calif.
PNEUMATIC HAMMER DEVELOPMENT
R. A. Thompson Jul. 1967 29 p
(Contract AT(29-1)-789)
(SCL-DR-67-48) CFSTI: HC $3.00/MF $0.65

A gas gun has been developed for low stress level (1 to 20 kilobars) impact studies. The projectile face and impact surface are designed so that a planar impact is obtained with an accompanying fast stress-wave rise time. The projectile velocity is measured just before impact. The simplicity of operation provides the capability of many tests per day. Author (NSA)

N67-39238# California Univ., Los Angeles. Div. of Research.
DIGITAL SIMULATION OF NUMERICALLY CONTROLLED PRODUCTION SYSTEMS
Gastone Chingari (Sperry Rand Corp.) May 1967 78 p refs
(NASA-RP-14)

The nature of numerically controlled production systems was studied to determine the basic principles of their operation. Using these principles, a methodology of digital simulation was formulated on the basis of the generalized functions identified in the component subsystems. The generalized functions and their interrelationships were formally expressed in a numerical control production systems simulator. Design criteria and the structure of the simulator, a computer based generalized model serving to illustrate the methodology and to conduct experimental investigations in system behavior with different system topologies or under different disciplines of operation, are described. R.N.A.

N67-39289# Sandia Corp., Livermore, Calif.
ELECTROPLATING URANIUM WITH NICKEL
P. D. Anderson and P. R. Coronado Jul. 1967 35 p refs
(Contract AT(29-1)-789)
(SCL-DR-67-43; SCTM-14-63-81) CFSTI: HC $3.00/MF $0.65

Development of a process for reliably plating uranium with an adherent protective coating of nickel is reported. A method for evaluating specimens is presented with detailed results. Complete process instructions are given together with experimental data on some effects of deviating from these instructions. Author (NSA)

N67-39290# Sandia Corp., Livermore, Calif.
ELECTROPLATING URANIUM WITH NICKEL, SUPPLEMENT
J. W. Dini and P. R. Coronado Jul. 1967 22 p refs Suppl. to SCL-DR-67-43, Jul. 1967
(Contract AT(29-1)-789)
(SCL-DR-67-44; SCL-TM-65-33) CFSTI: HC $3.00/MF $0.65

Improvements in the process for reliably plating U with an adherent and protective coat of Ni are given. Specifically, a superior pretreating solution using $NiCl_2$ rather than SnCl is described, as well as a new method for cleaning pieces to be plated. Author (NSA)

N67-39292*# Boeing Co., Seattle, Wash. Aerospace Group.
IDENTIFYING OPTIMUM PARAMETERS OF HOT EXTRUSIONS Progress Report, 14 Jul.–17 Oct. 1967
17 Oct. 1967 24 p refs
(Contract NAS7-276)
(NASA-CR-89304; PR-14) CFSTI: HC $3.00/MF $0.65 CSCL 13H

Further testing of the effect of annealing on the strength of extruded MgO has been conducted. An insufficient number of satisfactory samples was available for making firm conclusions; however, results appear to be consistent with the hypothesis that work hardening protects surfaces from minor flaws. Somewhat lower relative annealed strengths are observed with finer grain sizes while somewhat higher relative annealed strengths are observed with larger grain sizes. Possible causes of this effect are discussed. Limited ductility was observed in testing extruded MgO (derived from fused single crystals) at 1540°C. Fracture strengths are not much lower than those at 1315°C or room temperature. Possible reasons for this fact are discussed. Fracture appears to originate at or near triple points, but propagates mostly by cleavage at this temperature, as was the case at 1315°C. Comparison of grain sizes just before and after extrusion corroborate previous evidence that the transverse grain size was determined primarily by physical reduction of grains in proportion to the reduction ratio. Author

N67-39342*# Bureau of Mines, Boulder City, Nev.
MOLTEN-SALT ELECTROREFINING VANADIUM SCRAP
K. P. V. Lei and T. A. Sullivan Oct. 1967 23 p refs
(BM-RI-7036) CSCL 13H

The Bureau of Mines investigated molten-salt electrorefining as a practical method for reclaiming vanadium from vanadium scrap. An electrolytic process utilizing a KCl–LiCl–VCl_2 electrolyte at 615°C was developed for producing ductile vanadium with a purity over 99.9 percent. The recovery of the vanadium in the cell feed ranged from 88 to 93 percent with a current efficiency from 83 to 95 percent. Author

N67-39362 British Gear Manufacturers Association, Sheffield (England).
THE DESIGN, MANUFACTURE AND USE OF BEARINGS IN POWER TRANSMISSION MACHINERY
Nov. 1966 31 p ref Presented at the Brit. Gear Manuf. Assoc. Tech. Meeting, 9 Nov. 1966

CONTENTS:

1. PLAIN BEARINGS FOR POWER TRANSMISSION MACHINERY S. O. Rafique (Glacier Metal Co.) p 1–10 ref (See N67-39363 23-15)

2. ROLLING BEARINGS FOR POWER TRANSMISSION MACHINERY P. A. Champion (Skefko Ball Bearing Co.) p 11–25 (See N67-39364 23-15)

N67-39363 Glacier Metal Co., Ltd., Wembley (England).
PLAIN BEARINGS FOR POWER TRANSMISSION MACHINERY
S. O. Rafique *In* Brit. Gear Manuf. Assoc., The Design, Manuf. and Use of Bearings in Power Transmission Machinery Nov. 1966 p 1–10 ref (See N67-39362 23-15)

Problems in designing plain bearings for power transmission machinery, are discussed. Applications in which there is interaction, are discussed; particularly with respect to marine machinery. The load carrying capacity/speed interaction in marine machinery, and the utilization of the interaction in manufacturing rolling mill machinery, is described. Also discussed are the technique of starting up electrical motors, and the coefficient of friction in gearboxes. L.S.

N67-39364 Skefko Ball Bearing Co., Ltd., Luton (England).
ROLLING BEARINGS FOR POWER TRANSMISSION MACHINERY
P. A. Champion *In* Brit. Gear Manuf. Assoc., The Design, Manuf. and Use of Bearings in Power Transmission Machinery Nov. 1966 p 11–25 (See N67-39362 23-15)

Design requirements for rolling bearings used in power transmission machinery (gearboxes) are discussed. The advantages and disadvantages of single row deep groove, cylindrical, spherical, angular contact, needle, and ball thrust roller bearing types are considered. The location, mounting, fitting with oil injection, and selection of bearings is described. Worm gears, bearing size, bearing life, and bearing applicability to a particular machine, are also discussed. L.S.

N67-39380*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
RELIABILITY-CONFIDENCE COMBINATIONS FOR SMALL-SAMPLE TESTS OF AEROSPACE ORDNANCE ITEMS
A. G. Benedict 15 Oct. 1967 9 p ref
(Contract NAS7-100)
(NASA-CR-89303; JPL-TR-32-1166) CFSTI: HC $3.00/MF $0.65 CSCL 14D

Analyses epitomized by the widely-used equation $\gamma = 1 - R^n$ are shown to provide unexpectedly reasonable approximations for small-sample tests of aerospace ordnance items; high-reliability, low-confidence combinations are discussed. Author

16 MASERS

Includes applications of masers and lasers. For basic research see: 26 Physics, Solid State.

N67-38721# United Aircraft Corp., East Hartford, Conn. Research Labs.
RESEARCH INVESTIGATION OF LASER LINE PROFILES Annual Technical Report, 1 Aug. 1966–31 Jul. 1967

Anthony J. De Maria, George L. Lamb, Jr., David A. Stetser, and Carl M. Ferrar 28 Aug. 1967 44 p refs
(Contract N00014-66-C-0344; ARPA Order 306; Proj. Defender)
(F-920479-4; AD-657210)

The objective of this program was to conduct experimental and theoretical investigations of laser line profiles. The broadened homogeneous line width of an argon ion laser was studied as a function of pressure and excitation by means of the Lamb Dip technique. Broadened homogeneous line widths of 200 to 400 MHz were recorded. These line widths are much larger than the 100 MHz radiative line width. The most plausible source for the boradened line is nonradiative phase interruptions occuring from small-angle Coulomb scattering in ion-ion collisions. It is shown that the line width decreases with increasing pressure for a certain range of laser oscillation. A simple collision broadening approach is not applicable to the ion system because of the behavior of the ion density as a function of pressure and excitation. Preliminary experiments were also performed with a CO2-N2-He laser and no experimental indication of a Lamb Dip was found for this laser medium. Some aspects of the theory of a gas laser recently developed by W. E. Lamb, Jr. have been recast in a form which more fully displays the role played by the particle dynamics. It is shown that effects due to long range forces are most noticeable at long optical wavelengths and when there is a large difference between the lifetimes of the two-laser levels. Author (TAB)

N67-38868*# Radio Corp. of America, Princeton, N. J. Microwave Applied Research Lab.
DEVELOPMENT OF A 10.6-MICRON LASER MODULATOR Final Report, 18 Feb.–18 Jul. 1966
T. Walsh 18 Jul. 1966 23 p refs
(Contract NAS5-10144)
(NASA-CR-89267) CFSTI: HC $3.00/MF $0.65 CSCL 20E

Electro-optic modulation, crystal growth and properties, and design equations and performance are reported for a 10.6-micron laser modulator of gallium arsenide. The constructed GaAs modulator gives 61% depth of modulation for 1000 volts peak modulating signal over a bandwidth from dc to more than 20 MHz. Efficient and compact quarter wave plate and polarizers were developed for use at the 10.6-micron wavelength. The modulator was used to measure the electro-optic coefficient of GaAs over the 2.5 to 12 micron range by placing the GaAs crystal between parallel polarizers. A thick CdS wave plate, also placed between the polarizers, was oriented with its fast axis at 45° to the plane of passage of the polarizers. Phase retardation increased as the wavelengths became shorter. M.W.R

N67-39196# Sandia Corp., Albuquerque, N. Mex.
A MOBILE LASER TRANSCEIVER USED FOR DETECTING LONG RANGE, SLOW VELOCITY, AND LOW DENSITY TARGETS
M. J. Landry and J. R. Lochner Apr. 1967 21 p Presented at the 1st Intern. Conf. on Laser Appl. and World Exhibition of Instr. and Laser Tech., Paris
(Contract AT(29-1)-789)
(SC-DC-67-1596; CONF-670716-1) CFSTI: HC $3.00/MF $0.65

Two mobile laser transceivers to detect artificial clouds comprised of ablative materials from SNAP reentry vehicles for use in aerospace nuclear safety are described. The transceivers consist of ruby laser transmitters, mobile receivers, photomultiplier tube detectors, oscilloscope camera timing generators for recording, and power supplies. Atmospheric clouds were detected at a 26 mile range at night and at 43.2 mile range in daytime. NSA

N67-39363*# Varian Associates, Beverly, Mass. Quantum Electronics Div.
STUDY IMPROVEMENT OF THE HYDROGEN MASER. Final Report, 30 Jul. 1966–31 Aug. 1966
R. F. C. Vessot, M. R. Baker, and M. W. Levine 18 Jan. 1967 40 p refs
(Contract NAS5-9888)
(NASA-CR-89275) CSCL 20E

Technical discussions are presented on components and techniques developed for greater ease of operation and maintenance and for field use. Details are given on the resistance-heated, water-cooled tungsten foil thermal dissociator. The hydrogen atom trajectories through magnetic fields of hexapolar symmetry are calculated. The automatic tuning system is analyzed and its components are described. Optimization of the bulb shape is discussed. N.E.N.

17 MATERIALS, METALLIC

Includes cermets; corrosion; physical and mechanical properties of materials; metallurgy; and applications as structural materials. For basic research see: 06 Chemistry. For related information see also: 18 Materials, Nonmetallic; and 32 Structural Mechanics.

N67-38130# California Univ., Los Angeles. Dept. of Engineering.
THE STUDY OF THE GROWTH MECHANISMS OF ALLOY FILAMENTARY CRYSTALS (WHISKERS) GROWN FROM SOLIDS Final Summary Report
George Sines Jun. 1967 19 p refs
(Contract Nonr-233(77))
(Rept.-67-26; AD-655917)

In an attempt to discover the mechanism by which the transport of atoms occurs under extreme microscopic stress gradients, alloy filamentary crystals were grown from the solid plating subjected to lateral compression. Enrichment of one species in the filamentary crystal would be expected if diffusion were the controlling mechanism. X-ray lattice diffraction measurement of the atomic spacing of Pb-In and Sn-In alloys appears promising. Also electron microprobe appears promising if shape and size effects can be calibrated. Absolute composition measurements are still inconclusive but the variation of composition along several filamentary crystals was less than 1%. Author (TAB)

N67-38141*# Westinghouse Electric Corp., Pittsburgh, Pa.
CORROSION OF ALUMINUM IN WATER
D. N. Fultonberg Washington, NASA, Oct. 1967 82 p refs
(Contract NAS3-5215)
(NASA-CR-899; WCAP-7029) CFSTI: HC $3.00/MF $0.65 CSCL 18J

Tests were performed in autoclave systems and in pumped loops in order to determine the corrosion and hydrogen generation of aluminum when subjected to conditions typical of those anticipated in a Tungsten Water-Moderated Reactor (TWMR). These tests, the equipment used, and the results obtained are discussed. It was concluded that the hydrogen generation could be excessive under certain conditions and that a broader program would be necessary in order to predict it with some confidence. Author

N67-38172# Naval Research Lab., Washington, D. C.
MARINE CORROSION STUDIES: THE ELECTROCHEMICAL CHARACTERISTICS OF SEVERAL PROPRIETARY ALUMINUM GALVANIC-ANODE MATERIALS IN SEA WATER Interim Report
T. J. Lennox, Jr., M. H. Peterson, and R. E. Goover May 1967 43 p refs
(NRL-MR-1792; AD-656899)

A series of experiments is described which was designed to obtain the electrochemical efficiency, electrochemical potential, and current output versus time data for five proprietary aluminum alloys using full-size anodes in sea water under conditions which approach those encountered in service. High and dependable electrochemical efficiency, sustained current output versus time characteristics, and elimination of inherently high resistance between cast-in steel cores and the anode metal must be realized before aluminum anodes can be considered for general Navy use. TAB

N67-38175# Naval Radiological Defense Lab., San Francisco, Calif.
CORROSION STUDIES OF HAYNES 25 ALLOY IN SEAWATER USING ELECTROCHEMICAL TECHNIQUES
Donald A. Kubose and Herman I. Cordova 16 May 1967 31 p refs
(Contract AT(49-5)-2084)
(USNRDL-TR-67-64; AD-656897)

Electrochemical corrosion rate measurements were made on uncoated, emissively coated and thermally shocked and uncoated specimens of Haynes 25 alloy in seawater at room temperature and 90C. The corrosion rates of the emissively coated specimens were about an order of magnitude higher than those of the uncoated specimens. No significant difference between the corrosion rates measured at room temperature and at 90C was observed for either the uncoated or the emissively coated specimens. Thermal shocking of uncoated specimens (by quenching from 500C to room temperature) did not increase their corrosion rates. The corrosion rates observed were on the order of 0.003 mils per year (mpy) for the uncoated and the thermally shocked uncoated specimens and 0.04 mpy for the emissively coated specimens. Author (TAB)

N67-38350*# Materials Research Lab., Inc., Richton Park, Ill.
ELEVATED TEMPERATURE STRESS CORROSION OF HIGH STRENGTH SHEET MATERIALS IN THE PRESENCE OF STRESS CONCENTRATORS Final Report
R. G. Lingwall and E. J. Ripling Aug. 1967 35 p refs
(Contract NASr-50)
(NASA-CR-88979) CFSTI: HC$3.00/MF$0.65 CSCL 11F

Experiments on the electrochemical aspects of hot salt cracking of titanium alloys suggest that cracking occurs due to the formation of an oxygen differential cell. Cracking occurs only at the cathode of the cell, and can be prevented by impressing an anodic potential on the stressed titanium. Hydrogen produced at the cathode where it enters the metal is deduced to be the basic cracking agent. Author

N67-38358# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
FORMATION AND CHARACTERIZATION OF AN A15-TYPE STRUCTURE IN CHEMICAL VAPOR DEPOSITED TUNGSTEN–RHENIUM ALLOYS
J. I. Federer and J. E. Spruiell (Tenn. Univ.) [1966] 25 p refs Presented at the Conf. on Chem. Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.
(Contract W-7405-ENG-26)
(ORNL-P-3101; CONF-670905-2) CFSTI: HC$3.00/MF$0.65

An A15-type phase in vapor-deposited W–Re alloys was identified by X-ray diffraction, metallography, and hardness measurements. The composition range of this A15-type phase varied with temperature, but was near W_3Re; at 1000 to 1500°C, the phase occurred alone or coexisted with the tungsten-rich terminal solid solution (β) or with sigma phase (σ). The phase was harder than β, limiting the usefulness of alloys containing the phase as a major constituent. Transformation to β or to $\beta+\sigma$ phases during long time anneals at deposition temperatures showed that the phase was metastable. Based on a proposed reason for formation during deposition, the phase would not be expected to form in β or $\beta+\sigma$ phase alloys subjected to service at elevated temperatures. Author (NSA)

N67-38370# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
IRRADIATION OF U_3Si. INTERIM RESULTS AFTER 7300 MWd/tonne U
M. A. Feraday, G. H. Chalder, and K. D. Cotnam Apr. 1967 34 p refs
(AECL-2684; EXP-NRX-52208) CFSTI: HC$3.00/MF$0.65

Enriched U–Si alloy specimens close to the U_3Si composition (U-3.9 wt % Si) and clad in Zircaloy-2 are being irradiated in the X-5 pressurized-water loop at powers of 600 to 800 W/cm length. Extrapolation of the swelling curve indicated a total volume increase in U_3Si of 13% after a burnup of 10,000 MWd/tonne U. Destructive examination of selected specimens showed that the U_3Si was plastic enough to flow into a 7 vol % central void provided in the fuel, suggesting that the total volume increase could be accommodated without excessive sheath strain. Author (NSA)

N67-38441# Atomic Energy Commission Research Establishment, Riso (Denmark).
GROWING BETA-BRASS SINGLE CRYSTALS
J. Als-Nielsen and W. Kofoed Mar. 1967 9 p refs
(RISO-149)

The apparatus for growing large single crystals by the Bridgman method is described, and the growth of beta-brass crystals is discussed in particular. Evaporation of Zn is avoided by encapsulating the graphite crucible in a stainless steel container, and with an appropriate growth rate of 7 mm/hr through a temperature gradient of 14°C/cm large perfect crystals (100 grams) were obtained from the melt. Author (NSA)

N67-38510# National Academy of Sciences—National Research Council, Washington, D. C.
A HISTORICAL VIEW OF ONE AREA OF APPLIED SCIENCE—METALLURGY
Cyril Stanley Smith *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 57–71 refs (See N67-38508 23-34)

The relationship between pure science and technical practices in the field of metallurgy and materials science are treated in an historical sense. A general discussion of the evolution of the applied science of metallurgy and eventual growth of a materials science branch is included, with emphasis on the practical innovations which lead to the increasing knowledge of materials as a science. M.W.R.

N67-38674# General Electric Co., Pleasanton, Calif. Nuclear Technology Dept.
STAINLESS STEEL FAILURE INVESTIGATION PROGRAM Quarterly Report, Jul. 1–Oct. 31, 1966
R. N. Duncan, comp. Dec. 1966 58 p refs
(Contract AT(04-3)-189)
(GEAP-5281; QR-6; EURAEC-1831) CFSTI: HC$3.00/MF$0.65

Results of corrosion tests on high-purity stainless steels, with minor additions of impurities, conducted in solutions of HNO_3+Cr^{+6}, and in $FeCl_2$ are reported. Specimens of types 348 and 304 stainless steel cladding were evaluated for susceptibility to intergranular attack before and after irradiation. Research on effects of applied stresses on fuel cladding as related to intergranular corrosion attack indicates that low-cycle fatigue is not a significant factor in intergranular failure mechanisms, that corrosion film material is not propagated into the cladding by cyclic fissing, but

that surface strains of 0.006 in./in. can be related to formation or presence of integranular attack in irradiated unsensitized type-304 stainless steel after operation in a BWR environment. NSA

N67-38577# Mississippi Univ., University. Dept. of Physics and Astronomy.
THE EFFECTS OF NEUTRON IRRADIATION ON THE RESISTIVITY OF BINARY ALLOYS
A. B. Lewis 12 Jun. 1967 12 p
(Contract AT(40-1)-2891)
(ORO-2891-6) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: neutron radiation effects on resistivity of Al–Cu alloys; radiation effects on thermoelectric properties of alloys; fabrication of porous metallic targets; and measurement of neutron flux and energy spectrum. Accelerator operation is also described. The neutron irradiated Al–Cu alloys showed an essentially uniform and small decrease in resistance. Due to the difficulties of cutting Be sheet to the required shape, it was decided to buy prefabricated Be parts for the preparation of Be-faced porous targets. NSA

N67-38586# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.
THE TEMPERATURE AND TIME DEPENDENCE OF THE HARDNESS OF IRON AND NICKEL
J. Larsen-Badse (Hawaii Univ.) Jul. 1967 25 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1861) CFSTI: HC $3.00/MF $0.65

Vickers hardness testing was carried out on Armco iron and pure Ni at 400 to 800°C. The load was 1 kg and the time of loading was varied between 15 sec and 1 hr. The hot-hardness values were shown to be most easily analyzed by considering them to consist of a temperature–dependent and a time–dependent contribution. The temperature–dependent part is intimately related to the flow stress of the material while the time–dependent part is a function of the creep properties. Activation energies for indentation creep as well as the exponent of stress dependence of the creep strain rate at low stresses can be determined rapidly from hot-hardness data. Author (NSA)

N67-38611# McMaster Univ., Hamilton (Ontario). Dept. of Metallurgy and Materials Science.
THE EMBRITTLEMENT OF COPPER-17 ATOMIC % ALUMINUM ALLOY BY LIQUID MERCURY
M. B. Ives and P. C. Hancock Aug. 1967 108 p refs
(Contract Nonr-3925(00))
(TR-9; AD-657379)

The role of plastic deformation in the initiation and propagation of cracks in Cu-17A1 alloy embrittled by liquid mercury has been studied. It is proposed that extensive plastic deformation and work hardening must occur at the crack-tip during propagation in order to raise the local flow stress to a critical level at which the maximum normal stress is equal to the cohesive strength. Strong indication is given that a critical applied stress criterion for fracture is not applicable for this material. Micro-cracks are formed at weakened grain boundaries and a period of stable crack growth made over a period of increasing applied stress may be necessary before the crack is long enough to become unstable.
Author (TAB)

N67-38640# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
QUANTITATIVE ANALYSIS OF TEXTURES PRODUCED IN A HOT-EXTRUDED ZIRCONIUM PLATE [ANALYSE QUANTITATIVE DES TEXTURES DEVELOPPEES DANS UNE PLAQUE DE ZIRCONIUM FILEE A CHAUD]
Jean-Claude Couterne (Ph.D. Thesis—Paris Univ., Orsay, France) Jan. 1967 106 p refs In FRENCH
(CEA-R-3127)

The textures produced in zirconium by extrusion at 730°C of a cylindrical billet in the form of a plate having a rectangular cross section have been studied by the Schulz method using an isotropic standard. These textures have been determined both parallel to the plane of the plate and parallel to the plane of the sides. The results were analyzed, and it was found that particularly near the edges of the plate certain components of the textures observed in the two series of recordings are in fact aspects of the same texture seen from two different angles. It was also found that the zirconium thus shaped has cold-work textures, and also recrystallization textures formed after the preceding cold-working. If the observed textures are considered schematically, two of these are similar to those found in rolled products: these textures are such that the (0001) planes are inclined at 35° and 60°, respectively, with respect to a plane tangential to the curve (envelope of transverse flow rates) resulting from the extrusion geometry under consideration; the third texture is defined by the fact that the (0001) plane is orthogonal to the exterior surfaces of the plate. The direction of extrusion associated with these planes and common to the three textures is of the type ⟨1010⟩. Dilatometric tests have been carried out on samples taken both parallel and perpendicular to the extrusion direction. These tests show that the zirconium is dilatometrically anisotropic and that a plot of $(\alpha_v)_a$ against temperature shows a change of gradient at 400°C; this latter effect may be due to the change in the electronic configuration of the metal occurring at this temperature. Author (NSA)

N67-38669# Battelle Memorial Inst., Columbus, Ohio.
SPECIFIC HEATS AND HEATS OF TRANSFORMATION OF ZIRCALOY-2 AND LOW-NICKEL ZIRCALOY-2
Edward A. Eldridge and Herbert W. Deem 31 May 1967 17 p refs
(Contracts W-7405-ENG-92; NObs-88095)
(BMI-1803) CFSTI: HC $3.00/MF $0.65

Measured were enthalpy and specific heat of Zircaloy-2 and low-nickel Zircaloy-2 for use in predicting reactor behavior under normal and accidental transient temperature conditions. The measurements were made in an all-metal calorimeter well in a Bunsen ice calorimeter. The specific heats of Zircaloy-2 and low-nickel Zircaloy-2 at 0°C were 0.068 and 0.069 cal/(g) (C), respectively, while at 1050°C the specific heat was 0.085 cal/(g) (C) for both alloys. Enthalpy-versus-temperature data for Zircaloy-2 showed a break at 635°C with an enthalpy increase estimated to be 0.38 cal per g. Low-nickel Zircaloy-2 enthalpy showed a corresponding increase of 0.35 cal per g between 570° and 600°C. The α–β transformation for both materials started at 810°C and continued to 975°C; the heat of transformation for each material was 10.6 cal per g. An inflection in the specific-heat curve was noted between 825° and 875°C. K.W.

N67-38671# Denver Research Inst., Colo.
THE DETERMINATION OF THE NIOBIUM-RICH REGION OF THE TERNARY PHASE DIAGRAM, NIOBIUM–ALUMINUM–ZIRCONIUM. PHASE EQUILIBRIA OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS. STUDIES OF THE EFFECT OF INTERSTITIAL ADDITION ON THE PHASE EQUILIBRIA OF THE NIOBIUM-RICH REGION OF THE NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM ALLOY SYSTEMS Summary Report
Albert S. Yamamoto May 1967 92 p
(Contract AT(11-1)-1092)
(DRI-2397; DRI-1092-241) CFSTI: HC $3.00/MF $0.65

Phase equilibria studies in the Nb-rich region of the three ternary alloy systems, Nb–Al–Zr, Nb–W–Hf, and Nb–W–Zr, were conducted using metallographic techniques as the primary tool.

X-ray diffraction analysis data aided in the microscopic interpretation of the annealed-and-quenched alloy structure and the construction of isothermal sections in each alloy system. Additionally, the effect of small C and/or O additions on the phase equilibria in the Nb-rich region of the Nb–W–Hf and Nb–W–Zr systems was investigated using the same techniques. Author (NSA)

N67-38674# Los Alamos Scientific Lab., N. Mex.
STATISTICAL-MECHANIC INTERPRETATION OF THE SOLUBILITY ISOTHERM OF HYDROGEN IN HYDRIDE PHASE FOR THE METALS PALLADIUM, VANADIUM, NIOBIUM, AND TANTALUM
R. V. Bucur and M. Crisan [1967] 9 p refs Transl. into ENGLISH from J. Phys. Chem. Solids, v. 28, 1967 p 995–1000
(LA-TR-67-55) CFSTI: HC $3.00/MF $0.65

A statistical-mechanic interpretation of the phenomenon of H dissolution in the hydride phase is presented for the metals Pd, V, Nb, and Ta on the basis of a model that assumes association of atoms in pairs in the vacant sites of the lattice and perfect solid solution behavior. The equation of the solubility isotherm (Langmuir type) thus deduced can be verified experimentally. Author (NSA)

N67-38811*# Allied Research Associates, Inc., Concord, Mass.
STRUCTURAL MEASURES OF DUCTILITY FOR TITANIUM ALLOY Ti–6Al–4V AND 18% NICKEL MARAGING STEEL (250) Final Technical Report
Ralph Papirno and Peter Kyle 1 Aug. 1967 75 p refs
(Contract NASw-1423)
(NASA-CR-89260; ARA-336-4) CFSTI: HC $3.00/MF $0.65 CSCL 11F

Notch tests on aged titanium alloy, Ti–6Al–4V and aged 18% nickel maraging steel were performed using specimens with a range of elastic stress concentration factors from 3 to 13.5 to evaluate the ductility ratio. The steel material displayed marked anisotropy in ductility behavior exhibiting notch insensitivity in the longitudinal direction and notch sensitivity in the transverse direction. Average four-mil gage length permanent strains, measured along the fracture using photogrid techniques, were approximately 60%–65% with some observations of strains higher than 100% for both materials. The two-inch gage length strain values averaged approximately 7% for the titanium and 2.5% for the steel material. Ductility ratio and strength data for steel in the transverse directions are in good agreement with Gerard's strength–ductility relation for limited ductility materials, while the titanium data are not. The lack of agreement of the titanium data is believed to be associated with their low values of ductility ratio, placing these materials outside of the limited ductility category. Design data for all the materials are presented and the efficiency of the materials in design is compared. Author

N67-38825# Stanford Univ., Calif. Dept. of Materials Science.
ROLE OF DIFFUSION IN CREEP AND STRESS-RUPTURE IN SOLIDS Final Report
Oleg D. Sherby and John C. Shyne 1 Aug. 1967 19 p refs
(Contract Nonr-225(60))
(SU-DMS-67-35; AD-657197)

The subject matter of the report relates to the mechanical behavior of polycrystalline solids at elevated temperature and the results obtained are described under four separate headings, namely: (A) Grain size effects on creep behavior, (B) Stacking fault energy effects on creep behavior, (C) Influence of second hard phase on mechanical behavior and (D) Modes of deformation in high temperature creep. Author (TAB)

N67-38837 Comitato Nazionale per l'Energia Nucleare, Casaccia (Italy). Centro di Studi Nucleari.
STUDY ON TERNARY ALLOYS OF URANIUM-MOLYBDENUM–NIOBUM AND URANIUM-MOLYBDENUM–ZIRCONIUM WITH LOW ALLOYING CONTENT [STUDIO DI LEGHE TERNARIE DI URANIO–MOLIBDENO–NIOBIO E URANIO–MOLIBDENO–ZIRCONIO A BASSO TENORE DI LEGANTE] Final Report
C. Fizzotti and A. Masperoni Jun. 1967 71 p In ITALIAN; ENGLISH summary
(Contract EURATOM-001-62-6 TEGI)
(EUR-3479 i)

Small-quantity additions of such elements as molybdenum, niobium, zirconium, aluminum, silicon, iron, and carbon were considered for improving the behavior of uranium under neutron irradiation. Emphasis is on the ternary alloys uranium–molybdenum–niobium and uranium–molybdenum–zirconium. Evaluated were the effects of heat treatments, including continuous cooling, quenching and annealing, interrupted cooling, and interrupted quenching. Thermal stability tests consisted of aging and thermal cycling. Mechanical properties and corrosion characteristics were also investigated. Some characteristic isotherms of the uranium–molybdenum–niobium system are discussed. A selection criteria and heat treatments relevant to irradiation tests for these alloys are given. K.W.

N67-38851*# IIT Research Inst., Chicago, Ill.
METAL CARBIDE–GRAPHITE COMPOSITES Summary Report, 1 Aug. 1966–31 Jul. 1967
29 Sep. 1967 131 p refs
(Contract NASr-65(09))
(NASA-CR-89079) CFSTI: HC $3.00/MF $0.65 CSCL 11D

Niobium carbide-graphite and tantalum carbide-graphite composites were fabricated by hot pressing at 3000° to 3250°C. The effect of carbide content on physical and mechanical properties was evaluated at room temperature and up to 2800°C. Room temperature studies show that with increasing carbide content in either composite, strength properties and electric conductivity increase, and anisotropy in properties decreases. Tests at 2000°C for any composite reveal an increase in flexural strength, a decrease in flexural modulus, little change in tensile strength, and a decrease in compressive strength. These changes indicate that the material should have an improved thermal shock resistance when rapidly cycled between ambient and 2000°C. Resistance to high temperature deformation follows no trend as a function of carbide content. The tantalum composite shows superior structural integrity at high temperatures. Measurement of thermal expansion and conductivity shows a trend toward isotropic behavior with increasing carbide content. At 80 vol% carbide, the with-grain and across-grain values for thermal expansion are about the same. Author

N67-38862# California Univ., Berkeley. Lawrence Radiation Lab.
INVESTIGATION OF THE APPLICATION OF SPINODAL THEORY TO THE PALLADIUM–IRIDIUM SYSTEM
Gordon Walter (M.S. Thesis) May 1967 38 p refs
(Contract W-7405-ENG-48)
(UCRL-17470) CFSTI: HC $3.00/MF $0.65

Hardness, microstructural, and X-ray observations of a 9 at. % Pd–44 at. % Ir alloy were made to investigate the applicability of existing spinodal theory. Specimens of the Pd–Ir alloy were aged at temperatures well below the critical temperature predicted by existing theory. Classic spinodal decomposition was not found to occur in any of the studies even though specimens were aged long times. A theoretical justification is offered for this phenomenon. The modification of existing spinodal theory is based on effects of differing elastic moduli of the alloy components. Pd and Ir are excellent metals for such a study because the elastic modulus of Ir is nearly five times that of Pd. Author (NSA)

N67-38871# Nuclear Materials and Equipment Corp., Apollo, Pa.
GROWTH OF SINGLE CRYSTALS OF PLUTONIUM Progress Report, Jan. 1–Mar. 31, 1967
Jun. 1967 12 p refs
(Contract AT(30-1)-3428)
(NUMEC-3428-32) CFSTI: HC $3.00/MF $0.65

A parametric study to determine the effects of the primary recrystallized grain size and the amount of critical straining as related to the growth of large grains of Ga-stabilized delta-phase Pu was initiated, using the strain-anneal method for growing single crystals. After introducing a 0.3% critical strain into a 1.22 w/o Ga-stabilized delta-Pu tensile blank, having a primary recrystallized average grain size of 0.030 mm, grains were grown in the specimen to a diameter of 0.087 mm by annealing in a temperature-gradient furnace. Author (NSA)

N67-38910# Westinghouse Electric Corp., Pittsburgh, Pa. Advanced Reactors Div.
DEVELOPMENT OF HIGH STRENGTH VANADIUM ALLOYS Final Report, Dec. 1, 1964–Dec. 31, 1966
W. Pollack, R. W. Buckman, R. T. Begley, K. C. Thomas, and E. C. Bishop Jun. 1967 162 p refs
(Contract AT(30-1)-3487)
(WCAP-3487-16) CFSTI: HC $3.00/MF $0.65

A series of V-base alloys suitable for use as fuel cladding in liquid metal cooled fast breeder reactors was investigated. Forty-five 200-g. button melts and eight 2.5-inch diameter (3.5 lb.) ingots were melted. Solid solution strengthening was attained through additions of Cr, Fe, Nb, Mo, W, Ta, and Ti, while combinations of Zr or Ti and C or N were used to achieve dispersed phase strengthening. In addition, 2.5-inch diameter ingots of the reference V-10 Ti and V-20 Ti alloys were melted to provide a basis for comparing experimental alloys. The melts were processed to 0.042-inch sheet and characterized by hardness, tensile, and creep tests. An evaluation of weldability was conducted and attempts were made to identify precipitate phases observed in the microstructure. In addition, the compatibility of several alloys with ceramic fuels was investigated at 800°C, and 500-hour sodium corrosion tests were also performed. Author (NSA)

N67-38549# Chantiers de l'Atlantique Saint-Nazaire (France).
[PROPERTIES OF STEELS] Quarterly Report, Jan. 1–Mar. 31, 1967
C. Laymonie 31 May 1967 6 p Transl. into ENGLISH from French
(Contract EURATOM-054-61-12-RDF)
(EURAEC-1861; EUR-3365; QR-2.63; QR-8) CFSTI: HC $3.00/MF $0.65

Final results of research on austenization and mechanical properties of three steels are briefly summarized. NSA

N67-38987# Bettis Atomic Power Lab., Pittsburgh, Pa.
SLIDING-WEAR PERFORMANCE OF 135 MATERIAL COUPLES IN HIGH PURITY WATER AT 300°F AND 500°F
N. B. Dewees May 1967 83 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-314) CFSTI: HC $3.00/MF $0.65

Wear performance data are presented for 135 metallic material couples (42 materials) tested in various combinations in sliding wear in a high purity water environment. The composition of the materials tested, test procedure, and means of analyzing the data are given. The results are shown in chart form with a summary and an index. Results are evaluated according to the appearance of the worn surface, roughening tendency, wear rate, variability of wear rate with repeat testing, and consistency of wear rate under different conditions of testing. Wear performance on the rig used was compared with results from other wear test rigs. The wear evaluation for each material couple is valid for other applications having the same type of continuous motion and probably for reciprocating motion. Author (NSA)

N67-39025# General Electric Co., Schenectady, N. Y. Knolls Atomic Power Lab.
EFFECT OF NEUTRON IRRADIATION IN 550F LOOP WATER ON THE MECHANICAL PROPERTIES OF Ni–Cr–Fe ALLOY 600, Ni–Cr–Fe WELD METAL, AND TYPE 347 STAINLESS STEEL Final Report
A. E. Powers and E. E. Baldwin 27 Jan. 1967 31 p ref
(Contract W-31-109-ENG-52)
(KAPL-3161) CFSTI: HC $3.00/MF $0.65

Results of a program, initiated in 1959, to determine the effect of neutron irradiation on the mechanical properties of Ni–Cr–Fe Alloy 600, Ni–Cr–Fe Alloy 600 weld metal, and Type 347 stainless steel are presented. Irradiation was carried out in the Engineering Test Reactor (ETR) to a maximum dose of about 5×10^{21} nvt (>1 MeV). The increase in yield strength was proportional to the square root of the dose up to about 1×10^{21} nvt (>1 MeV). At 1×10^{21} nvt, a plateau was reached at yield strengths of 100,000 to 130,000 psi for both the Ni–Cr–Fe Alloy 600 and the Type 347 stainless steel. Elongation was a function of the yield strength, and the uniform elongation diminished to very small amounts when the yield strength was raised by irradiation to the ultimate strength of the unirradiated specimens. Author (NSA)

N67-39028# MSA Research Corp., Evans City, Pa.
RESULTS OF MECHANICAL PROPERTIES TESTS OF 304 SS SPECIMENS CONDUCTED IN: 1. 1200 F SODIUM CONTAMINATED WITH OXYGEN (≈300 ppm); 2. 1200 F SODIUM CONTAMINATED WITH CARBON
R. C. Andrews, R. H. Hiltz, L. H. Kirschler, S. J. Rodgers, and F. Tepper Jul. 1967 168 p
(Contract AT(11-1)-765)
(MSAR-67-103) CFSTI: HC $3.00/MF $0.65

The mechanical properties of one heat of 304 as were measured in two dynamic 1200°F Na systems, one of which was contaminated with carbon and the other which was contaminated with 300 ppM O_2. The effects of the two environments were evaluated by comparing mechanical properties with those in air. Both as-received and 4000-hour exposed materials were tested. Creep, creep-rupture, and fatigue tests were conducted in the flowing Na systems, while tensile tests were conducted in air at both room temperature and test temperature on the exposed material. Impact tests were conducted in air at room temperature. Metallurgical techniques used in post-test evaluation of the specimens and tabs included carbon analyses, microhardness measurements, microprobe analyses, metallographic analyses, standard X-ray diffraction, and chemical analyses of the extracted carbide phases. The effects of sequential exposure of 304 ss to high C and high O_2 were investigated. C increases of 5 Cr–1/2 Mo, 9 Cr–1 Mo, 304L, 304, 316L, 316, 321, 347 stainless steels, Inconel 600, and Incoloy 800 were measured for four different exposure times. Preliminary use of magnetic traps for removal of contaminants is discussed, as well as the post-test examinations of the piping from the two test loops. Na chemistry and the role it played in characterizing the test medium are discussed with emphasis on C analyses but also including O_2 and emission-spectrograph analyses. The relation of cold-trap temperature with the analyses of Na for O is shown for one of the test loops. Author (NSA)

N67-39031# National Engineering Lab., Glasgow (Scotland).
THE TECHNICAL BASIS OF STEEL SPECIFICATIONS
A. I. Smith and D. Scott Sep. 1966 37 p refs
(NEL-248) CFSTI: HC $3.00/MF $0.65

The historical development of testing procedures and specifications for iron and steel products is briefly reviewed, and basic concepts of engineering design are outlined. Complications which may be of critical importance in local stress/strain history during manufacture and in service are described. The purpose of mechanical testing and the relevance of manufacturing variables to performance in service are discussed, and the need for more systematic correlation of mechanical properties with structure of steels and behavior in practice is emphasized. Wider use of service-simulating tests is suggested. Future developments may require metallurgical design of materials. Author

N67-39036*# Boeing Scientific Research Labs., Seattle, Wash. Solid State Physics Lab.

STRESS CORROSION CRACKING OF TITANIUM ALLOYS: ELECTROCHEMICAL MASS-TRANSPORT-KINETIC MODEL, METALLURGICAL AND MECHANICAL EFFECTS, AND PROPOSED RELATION OF ELECTROCHEMICAL, METALLURGICAL AND MECHANICAL EFFECTS Quarterly Progress Report, 1 Apr.–30 Jun. 1967

T. R. Beck and M. J. Blackburn 30 Jun. 1967 128 p refs

(Contract NAS7-489)

(NASA-CR-89315; QPR-4) CFSTI: HC $3.00/MF $0.65 CSCL 11F

A continuum electrochemical mass-transport-kinetic model was formulated and computations were made on a digital computer, giving results that appear to be consistent with velocity-current-potential data for duplex annealed Ti:8–1–1. The model predicts that the electrochemically controlled velocity is determined by mass transport of chloride, bromide, or iodide ions to the crack tip. The tip current is equivalent to formation of an adsorbed monolayer of halide ions or titanium halide. The relation of velocity to bulk halide ion concentration indicates a recycling of halide ions by displacement or hydrolysis near the tip. Ti:8–1–1 and Ti–Al alloys heat treated to a very brittle condition give stress corrosion cracking velocities greater than predicted from the electrochemical model, indicating an additional mechanical mode of fracture related to rate of change of stress intensity. The velocity in the electrochemical mode appears to be related linearly to stress intensity factor. Ti:8–1–1 heat treated to a ductile condition gives stress corrosion cracking velocities less than predicted from the electrochemical model, suggesting that ductile phases retard crack propagation. Author

N67-39046# Chantiers de l'Atlantique Penhoet-Loire, Paris (France).

PLOTTING OF 1.2 MD 0.7 STEEL TRANSFORMATION CURVES FOR AUSTENITIZATION TEMPERATURES OF 900 AND 1100°C Special Report, Apr. 1–Jun. 30, 1966

1 Jun. 1966 9 p Transl. into ENGLISH from French *Its* Spec. Rept. No. 16

(Contract EURATOM-054-61-12-RDF)

(EURAEC-1687; EUR-2874) CFSTI: HC $3.00/MF $0.65

Progress in determining transition curves for austenization of a low-C alloy is reported. Tests were conducted under argon and specimens were austenized at 900°C and 1100°C for 30 min. Different types of cooling, from water quenching to cooling at a controlled rate of 80°C/hr were applied. Results of hardness tests and micrographic examinations, are shown as are the transformation diagrams. NSA

N67-39087# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

INDENTATION CREEP OF SOFT METALS

Jorgen Larsen-Badse Jul. 1967 37 p refs Presented at the 96th Ann. Meeting of the Am. Inst. of Mining, Met., Petrol. Engr., Los Angeles, 19–23 Feb. 1967

(Contract W-7405-ENG-26)

(ORNL-TM-1862; CONF-670206-6) CFSTI: HC $3.00/MF $0.65

The phenomenon of indentation creep found at room temperature when flat punches are pressed under constant load into the surface of soft metals was studied. The depth of penetration D was in all cases proportional to the square root of time: $D = S\sqrt{t}$. The constant S depends upon the metal, the load, and the type of punch used and is related to the punch pressure according to $S \propto p^n$. The exponent n is the same as that found for the low-stress creep relation $\epsilon \propto \sigma^n$; S may be considered to represent an average strain rate at a given depth of penetration and for a given punch size. The pressure required to obtain a certain S value decreases with an increase of the face area of the punch. This is due to the influence of punch size on the extent of the plastically strained zone and thus on the effective stress of deformation. Author (NSA)

N67-39089# Oak Ridge National Lab., Tenn. Metals and Ceramics Div.

MECHANICAL BEHAVIOR OF CVD TUNGSTEN AT ELEVATED TEMPERATURES

H. E. McCoy and J. O. Stiegler [1966] 50 p refs Presented at the Conf. on Chem. Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.

(Contract W-7405-ENG-26)

(ORNL-P-3159; CONF-670905-7) CFSTI: HC $3.00/MF $0.65

Creep-rupture tests at 1650 and 2200°C were made to evaluate the mechanical behavior of this material, and the properties compared with those of a typical heat of powder-metallurgy W. At 1650°C the CVD product has low fracture strains (approximately 5%) and a lower minimum creep rate. At high stresses the rupture life is shorter than that of the PM material; at low stresses the rupture lives are about equivalent. At 2200°C the minimum creep rate is higher and the rupture life lower for the CVD product. Microstructural features of importance noted in the CVD W include the formation and growth of voids, and the columnar nature of the grains. Fractographic techniques were used to study void nucleation and growth in the material. Nucleation appears to be spontaneous as the material is heated to elevated temperatures, indicating the presence of an impurity having a high vapor pressure. The growth appears to occur almost entirely by the stress-induced diffusion of vacancies into the void. At 2200°C under stress the voids reach such a large size that they comprise about 10% of the test specimen. Author (NSA)

N67-39150# Oak Ridge National Lab., Tenn.

FRACTURE OF Al–Al_2O_3 ALLOYS: FRACTURE ANALYSIS OF THE COMMERCIAL SAP-TYPE ALLOY XAP-001

D. G. Harman and T. A. Nolan Jul. 1967 18 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-1826) CFSTI: HC $3.00/MF $0.65

Fracture surfaces of XAP-001 dispersion-hardened Al were examined in the electron microscope using two-stage replication. The fracture surfaces were obtained from rod tensile specimens tested at −200 to 450°C or creep tested at 450°C. Three modes of ductile fracture are described and identified by fractography. High-temperature fractures are initiated as single oxide particles or groups of particles. Banding and stringering of oxide particles seriously affect the fracture process. Author (NSA)

N67-39206# California Univ., Livermore. Lawrence Radiation Lab.

CVD TUNGSTEN AND TUNGSTEN–RHENIUM ALLOYS FOR STRUCTURAL APPLICATIONS. PART I: PROCESS DEVELOPMENT

William R. Holman and Frank J. Huegel 16 Jun. 1967 39 p refs Presented at the Conf. on Chem. Vapor Deposition of Refractory Metals, Alloys, and Compds., Gatlinburg, Tenn., 12–14 Sep. 1967

(Contract W-7405-ENG-48)

(UCRL-70340, Pt. 1; CONF-670905-5) CFSTI: HC $3.00/MF $0.65

Results of a continuing program to develop CVD W and W Re alloy structures with mechanical properties comparable to those of wrought products are presented. Equipment, techniques, and the effects of deposition variables are discussed. Effects of heat treatment and correlations with mechanical properties are given in a companion paper. Short lengths of 1/2-in.-dia tubing were prepared by H_2 reduction of the metal fluoride(s) on the outer surface of rotating, heated mandrels. New developments include: accurate control of the flow rate and WF_6/ReF_6 ratio by positive displacement metering of premixed liquid fluorides into a flash evaporator, and modification of the microstructure by mechanically rubbing the surface during the deposition process. Effects of temperature, pressure, gas composition (H_2/MF_6 and WF_6/ReF_6), gas velocity, mandrel rpm, and rubbing conditions are correlated with composition, macrostructure, microstructure, and deposition rate. Interpretations of microprobe data, replicas of the surface, and growth-ring effects are also included. Results are discussed in terms of deposition mechanisms and their probable effects on mechanical properties. Author (NSA)

N67-39220# Los Alamos Scientific Lab., N. Mex.
CHEMICAL VAPOR DEPOSITION OF TUNGSTEN–MOLYBDENUM–RHENIUM TERNARY ALLOY
C. I. Fairchild [1966] 23 p refs Presented at the Conf. on Chem. Vapor Deposition of Refractory Metals, Gatlinburg, Tenn.
(Contract W-7405-ENG-36)
(LA-DC-8605; CONF-670905-9) CFSTI: HC $3.00/MF $0.65

Coatings of W–Mo–Re alloy compositions were deposited onto Cu or Mo substrates by the H_2 reduction of mixed WF_6, MoF_6, and ReF_6 gases at temperatures from 550 to 800°C and sub-atmospheric pressures of 10 to 200 torr. The volumetric ratio of H_2 to total fluoride was standardized at 10/1. Alloy compositions studied were in the range 60 to 85 W, 15 to 40 Mo, and 1 to 25 Re. Chemical analyses were used to determine overall and longitudinal compositions and electron microprobe analyses to determine radical concentrations of each element. Microstructural features of the coatings were determined metallographically. The microstructure of alloy deposits changed with deposition temperature from a dense, small grained structure at 600°C to a porous, large grain structure at 800°C. Interruptions in flow or large fluctuations in temperature and pressure caused a clearly defined layered deposit. Electron microprobe examination showed that high concentrations of Mo occurred at some interfaces of the layered structure. Chemical and metallographic analyses indicated that homogeneous, ternary alloy deposits in the range studied can be reproducibly obtained on short cylindrical surfaces (1 to 2 in. long) at 650°C and 10 torr pressure. Author (NSA)

N67-39224 Joint Publications Research Service, Washington, D. C.
TRANSLATIONS ON COMMUNIST CHINA: SCIENCE AND TECHNOLOGY NUMBER 390
1 Aug. 1967 26 p refs Transl. into ENGLISH from Wu Li Hsueh Pao (Peking), v. 22, no. 7, Jul. 1966 p 748–756, 757–764
(JPRS-42035; TT-67-32666) CFSTI: $3.00

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1. ON THE VISCOSITY OF LIQUID ALLOY NaK Y.-t. Tien p 1–11 refs (See N67-39225 23-17)
2. THE DENSITIES OF SODIUM, POTASSIUM AND THEIR ALLOY NaK C.-h. Liu p 12–21 refs (See N67-39226 23-17)

N67-39225 Joint Publications Research Service, Washington, D. C.
ON THE VISCOSITY OF LIQUID ALLOY NaK
Yin-t'ang T'ien *In its* Transl. on Communist China: Sci. and Technol. No. 390 1 Aug. 1967 p 1–11 refs (See N67-39224 23-17)

The viscosities of three types of NaK alloys (K: 49%, 51% and 74%) have been determined by the oscillating sphere method from 0° to 300°C. Results indicate that these liquid alloys obey the Andrade Law ($\eta = Be^{b/T}$). This article describes the experimental designs and determinations, as well as discusses certain problems of interest. Author

N67-39226 Joint Publications Research Service, Washington, D. C.
THE DENSITIES OF SODIUM, POTASSIUM AND THEIR ALLOY NaK
Ch'un-hsien Liu *In its* Transl. on Communist China: Sci. and Technol. No. 390 1 Aug. 1967 p 12–21 refs (See N67-39224 23-17)

The dilatometer method was used to determine the densities of liquid metallic sodium and potassium, and their alloy NaK from 0° to 300°C. The metals were over 99% purity. Results show that the densities of these metals and their alloy can be expressed by the linear function of temperature, with the exception that the (d,t) line of the NaK alloy deviates upward while approaching its melting point. Author

N67-39255# Stanford Univ., Calif.
MATERIALS IN ELECTROMAGNETS AND THEIR PROPERTIES
H. Brechna Jun. 1967 47 p refs Presented at the 2d Intern. Conf. on Magnet Technol., Oxford, Jul. 1967
(Contract AT(04-3)-515)
(SLAC-PUB-320; CONF-670705-6) CFSTI: HC $3.00/MF $0.65

Properties of low C and Si steels at room, elevated, and cryogenic temperatures such as magnetic and mechanical characteristics are discussed. The effect of impurities on coercive force, remanence field, and saturation values, as well as the influence of material inhomogeneities on field distribution in the useful aperture of magnets and on mechanical properties are given. Nonferromagnetic materials used in magnetizing coils as Cu and its alloys, Al of various grades and purities; their physical properties such as resistivity, specific heat, and magneto-resistance as a function of temperature and strain, are discussed. Also dealt with are various types and techniques of insulation based on structural material and thermoset composites, their properties, such as hygroscopicity, mechanical strength, and fatigue. External influences, such as effect of water vapor and radiation are discussed. A short section is devoted to various aspects of manufacturing and insulation techniques, as well as current and proposed means of destructive and nondestructive testing procedures and programs. Author (NSA)

18 MATERIALS, NONMETALLIC

Includes corrosion; physical and mechanical properties of materials (e.g., plastics); and elastomers, hydraulic fluids, etc. For basic research see: 06 Chemistry. For related information see also: 17 Materials, Metallic; 27 Propellants; and 32 Structural Mechanics.

N67-38080# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Materials Lab.
MECHANICAL BEHAVIOR OF BERYLLIUM WIRE REINFORCED PLASTIC COMPOSITES. PART I: STATIC MECHANICAL PROPERTIES Technical Report, Aug. 1965–Aug. 1966

H. S. Schwartz and R. T. Schwartz Jan. 1967 31 p refs
(AFML-TR-66-404, Pt. I; AD-657309)

Unidirectional and multidirectional composites of five mil diameter beryllium wire combined with an epoxy resin were fabricated and their mechanical behavior in tension, compression, flexure, and shear loading modes determined. The composites possessed good bonding between the filament and matrix. Continuity in the filament and matrix phases was apparently maintained at all stress levels up to failure. In general, the composite stress-strain behavior reflected that of the beryllium reinforcement, with an initial linear relationship followed by decreasing stress-strain rate to failure. The yield strengths of the composites at 0.2% offset strain were 80-90% of the ultimate strengths. The efficiency with which the beryllium reinforcement modulus and strength was translated into composite properties was greater than 80%. The composites failed by plastic deformation sometimes followed by buckling (compression) or fracture (tension). Plastic deformation in a composite may be desirable as a mechanism for redistributing local stress concentrations and increasing the energy required to cause failure. The specific elastic modulus and specific ultimate strength of the beryllium composites were high, but their proportional limits were less than one-third of the ultimate strength. Variation of the moduli with stress above the proportional limit is an important consideration, especially in connection with buckling phenomena. Author (TAB)

N67-38112# Massachusetts Univ., Amherst. Polymer Research Inst.
THE DICHROISM AND BIREFRINGENCE OF POLYMERS CONTAINING POLYENE SEGMENTS, PART I
Y. Shindo and R. S. Stein Jul. 1967 22 p refs
(Contract Nonr-3357(01))
(ONR-TR-91; AD-657352)

An extension of the Kuhn-Grun theory of birefringence of ideal rubbers is carried out where a distribution of statistical segment lengths is permitted. It is shown that at a given elongation, longer statistical segments will be oriented more highly than shorter ones. The application of the model to the dichroism of rubber-like networks is discussed. It is shown that the dichroism measurement may give a different measure of orientation than birefringence since it may arise from certain segments of the chain which are of different length from those contributing to birefringence. Author (TAB)

N67-38118# Naval Ordnance Lab., White Oak, Md. Chemistry Research Dept.
CALCULATION OF THE VOID CONTENT IN GLASS REINFORCED PLASTICS
Joseph E. Cuevas 14 Jul. 1967 17 p refs
(NOLTR-67-99; AD-657125)

A new approach is proposed for the calculation of voids in glass reinforced plastics. This approach takes into consideration experimental precision and available knowledge of the specific gravity of the materials used in the fabrication of glass reinforced plastics. Equations based on experimental data have been used as a basis for developing an equation to calculate void content. The technique herein presented gives non-negative void content values even on the more void-free composites. Author (TAB)

N67-38254# Naval Ordnance Test Station, China Lake, Calif.
PREPARATION OF DENSE ABLATIVE COMPACTS
C. A. Hering and W. S. McEwan Jun. 1967 15 p refs
(NOTS-TP-4376; AD-657308)

Attempts were made to fabricate a dense material that when heated would produce gaseous products and possibly a slag. Structural strength was an added requirement. In preliminary work tungsten was dispersed in a carbonate phase. This system was too weak mechanically to permit any evaluation whatsoever. In further experimentation attempts were made (1) to make tungsten the continuous phase by sintering tungsten powder by passage of an electric current through it, and (2) to make a compact bonded by tungsten compounds. Variations of these ideas were tried with only moderate success. Author (TAB)

N67-38277*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
HALL COEFFICIENT OF TANTALUM CARBIDE AS FUNCTION OF CARBON CONTENT AND TEMPERATURE
Gilbert J. Santoro and R. T. Dolloff Washington, NASA, Oct. 1967 10 p refs
(NASA-TN-D-4168) CFSTI: HC $3.00/MF $0.65 CSCL 20L

The Hall coefficient and the electrical resistivity of tantalum carbide (TaC) were investigated along the entire cubic-phase region (about $TaC_{0.74}$ to $TaC_{1.0}$) at room temperature and at −196°C. At both temperatures, the Hall coefficient was negative and decreased in magnitude with decreasing carbon content. Near the stoichiometric composition, the magnitude of the Hall coefficient was lower at −196°C than at room temperature but approached the room-temperature value at about $TaC_{0.9}$. The electrical resistivity increased with decreasing carbon content at both temperatures. The temperature dependence of the resistivity was small at higher carbon contents and negligible at $TaC_{0.9}$ and lower carbon contents. The magnetoresistivity was too small to be detected. The change in resistivity under an applied field of 14.7 kilogauss (1.47 T) was less than 10^{-6}. The results are discussed in terms of current hypotheses on the bonding of the group IV and V transition metal carbides and nitrides. Simplified band models cannot be used to adequately describe the experimental data of this investigation. Author

N67-38409# Columbia Univ., New York. Dept. of Civil Engineering and Engineering Mechanics.
FRACTOGRAPHIC STUDIES WITH A LINEAR POLYMER WITH SPECIAL CONSIDERATION OF FATIGUE FRACTURE
G. Jacoby and C. Cramer Apr. 1967 122 p refs
(Contract Nonr-266(91))
(TR-47; AD-657373)

The observation of fatigue striations on fatigue fracture surfaces of a linear polymer lead to a study of the fatigue fracture mechanism in this material. In order to understand the fatigue fracture the discussion had to be extended to include static tensile fracture, creep fracture and impact fracture. Interest has been concentrated on the appearance of the respective fracture surfaces as a possible clue to the different fracture mechanism because these surfaces reflect the processes involved in the fracture of solids. On the same basis the similarity between fracture phenomena in metals and in polymers is emphasized throughout the paper. The present study has lead to the formulation of a hypothesis for the fatigue mechanism in a linear polymer and of an analytical crack propagation law. Author (TAB)

N67-38444# Royal Aircraft Establishment, Farnborough (England).
THE PREDICTION OF SHELF-STORAGE LIFE IN RUBBERS FROM ACCELERATED HEAT AGING TESTS. PART I: ACCELERATED OVEN AGING
D. K. Thomas, R. Sinnott, and J. Day May 1967 18 p refs
(RAE-TR-67118) CFSTI: HC $3.00/MF $0.65

Oven aging experiments in which the mechanical tests are performed at the temperature of aging have been carried out on nitrile, neoprene, and hypalon rubbers. In all cases the variation of one or more of the mechanical properties with time at a series of temperatures allows predictions to be made of shelf-storage life at ambient temperature. Comparisons drawn between these predictions and the results of actual shelf-storage tests are encouraging. Author

N67-38537# Utah Univ., Salt Lake City. Dept. of Metallurgy.
EXTENDED STUDY OF GRAIN GROWTH OF THORIA GEL
Suk Joong Im and Milton E. Wadsworth 31 Jan. 1967 65 p refs Prepared for Union Carbide Nucl. Co.
(Contract W-7405-ENG-26)
(TR-33; TID-23884) CFSTI: HC $3.00/MF $0.65

In addition to grain size determination, during presoaking and firing, using electron microscopy and X-ray line broadening techniques, the density change was studied on each sample fired in the ambient atmosphere. Thoria gel samples were presoaked at 900°C for several hours in N_2 and H_2 atmospheres and the densities were measured by means of toluene displacement. Considering the densities (approximately 9.2) of the samples presoaked for 4 hours in N_2 and H_2 could approach the theoretical density when they are fired, examinations of average grain size as a function of time were carried out in N_2 and H_2 atmospheres. Similar studies were carried out in N_2 atmospheres at 1150°C after presoaking for 4 hours in N_2 atmospheres. Firing in H_2 produces enhanced grain growth and rate of densification, and the measured density change was not greatly affected by grain coarsening and grain refinement. Erratic grain growth was observed in the experiments under various conditions but was not observed for the samples fired at 1150°C for 800 minutes in N_2 atmosphere after presoaking at 900°C for 4 hours in N_2 atmosphere, and for the samples fired at 1050°C for 800 minutes in H_2 after 4 hours presoaking in H_2 atmosphere. Author (NSA)

N67-38570# Utah Univ., Salt Lake City. Dept. of Metallurgy.
SINTERING AND GRAIN GROWTH OF THORIA GELS CONTAINING CALCIUM OXIDE
Suck Joong Im and Milton E. Wadsworth 31 Jan. 1967 81 p refs Prepared for Union Carbide Corp.
(Contract W-7405-ENG-26)
(TID-23883; TR-29) CFSTI: HC $3.00/MF $0.65

The effect of Ca impurity on sintering of ThO_2 gel compacts was studied through measurements of shrinkage and grain growth. ThO_2 gels with various Ca concentrations were obtained by adding calcium nitrate up to 1% in weight. The average grain sizes of initial ThO_2 gels were in the range of 60 to 85 Å, and the maximum average grain size during sintering at 850°C was 300 Å. Grain boundary diffusion was found to explain the sintering data well except for higher temperatures above 850°C. Analysis of shrinkage data was done by use of a computer. The results showed increased sintering rate as the Ca concentration increased. The average activation energy, 45 kcal/mole, was virtually the same, within experimental error, as the result obtained by Daniels for plain gel. The effect of atmosphere on grain growth of plain gel compacts during sintering was studied in air and H_2 atmospheres. Results showed a slightly enhanced rate of grain growth in the H_2 atmosphere. The higher the Ca concentration the faster was the grain growth rate in air. At above 850°C, abnormal grain growth was observed when 1% Ca was present. From a correlation of grain growth and sintering, it was indicated that sintering occurred at normal rates (i.e., the grain boundary diffusion model was obeyed) only in the range of normal grain growth, below approximately 850°C for the 1% Ca–ThO_2 gels. Author (NSA)

N67-38571# Bendix Corp., Kansas City, Mo.
STRUCTURAL APPLICATION CHARACTERISTICS OF A RIGID URETHANE FOAM SYSTEM
C. H. Smith and S. L. de Gisi Oct. 1966 23 p refs Presented at the 154th Natl. Meeting of the Am. Chem. Soc., Chicago
(Contract AT[29-1]-813)
(BDX-613-95; CONF-670904-3) CFSTI: HC $3.00/MF $0.65

The effect of temperature on several physical properties of a rigid urethane foam system is reviewed. Foams at densities of 5, 10, 15, 20 and 25 pounds per cubic foot are included. The role of mold preheat temperature, isocyanate index and cure schedule on the compressive strength of the foam is also presented. Several aspects on the use of rigid foam for structural applications are discussed. Author (NSA)

N67-38715# Utah Univ., Salt Lake City. Dept. of Metallurgy.
SHRINKAGE MEASUREMENTS OF THORIA COMPACT-DT CONTAINING ADDED IMPURITIES
S. J. Im and M. E. Wadsworth 31 Jan. 1967 7 p refs Prepared for Union Carbide Corp.
(Contract W-7405-ENG-26)
(TID-23882) CFSTI: HC $3.00/MF $0.65

The shrinkage data for plain gel and DT-samples after sintering for about 300 min at 700°C and 900°C are presented and comparisons recorded. The increased shrinkage from 700°C to 900°C of the samples with added sulfate or phosphate was less than that of plain gel, and the shrinkage at given temperatures decreased as the concentration of sulfate or phosphate impurity in thoria gel was increased. NSA

N67-38833# Sandia Corp., Albuquerque, N. Mex.
NOVEL FERROCENE–URETHANE FOAM
Newton C. Fawcett, D. Richard Anderson, and Patrick E. Cassidy [1967] 4 p refs Presented at the 154th Natl. Meeting of the Am. Chem. Soc., Chicago
(Contract AT(29-1)-789)
(SC-DC-67-1831; CONF-670904-2) CFSTI: HC $3.00/MF $0.65

Preparation for a rigid urethane foam that includes 1,1′-bis(α-hydroxyethyl) ferrocene as part of the hydroxyl component is reported. Physical properties of the foam are similar to those of an ε-caprolactone-pentaerithritol polyester–PAPI polymethylene polyphenylisocyanate foam. Author (NSA)

N67-39090# Oak Ridge National Lab., Tenn. General Engineering and Construction Div.
EVALUATION OF A FOAMED NONRIGID PLASTIC AS A SEAL
J. W. Anderson (M.S. Thesis—Tenn. Univ., Knoxville) Jul. 1967 60 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1838) CFSTI: HC $3.00/MF $0.65

Use of a foamed nonrigid plastic as material to seal sleeve-type penetrations into cells maintained under negative pressures in radioactive processing was evaluated. Criteria were developed to define the desired material properties as related to the geometric design of the sleeve and plug, the fabrication and installation methods, and the operational environment. Flexible urethane foams and sponge or expanded cellular rubber products were selected for testing. Test equipment, procedures, and results are described. Closed-cell expanded neoprene seals may be satisfactory for installation in sleeve-type penetrations into radioactive hot cells at pressures up to 40 inches of water if the radiation exposure is substantially less than 10^8 roentgens. Author (NSA)

N67-39221# Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari.
SPECIFIC SURFACE MEASUREMENTS OF SINTERED UO_2 SAMPLES BY THE BET METHOD USING ^{133}Xe
L. Giarda, comp. and P. Knappik, ed. Apr. 1967 63 p refs Transl. into ENGLISH from Italian *Its* Spec. Rept.-2, R/505
(Contract EURATOM-043-65-TEEI (RD))
(EURAEC-1863; EUR-3367; R/505) CFSTI: HC $3.00/MF $0.65

Specific surface measurements were performed on UO_2 of different densities by the BET method; the pressure was measured by recording the radioactivity of ^{133}Xe. The values obtained were in the range 0.65 to 2.2 cm^2/g for theoretical densities of 92% and 2.0 to 6.7 cm^2/g for theoretical densities of 95%. Author (NSA)

N67-39250# Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires.
CONTRIBUTION TO THE STUDY OF OXYGEN SELF-DIFFUSION IN REFRACTORY OXIDES: APPLICATION TO URANIUM DIOXIDE [CONTRIBUTION A L'ETUDE DE L'AUTO-DIFFUSION DE L'OXYGENE DANS LES OXYDES REFRACTAIRES: APPLICATION AU DIOXYDE D'URANIUM]
Pierre Contamin and Rene Stefani Apr. 1967 32 p refs In FRENCH
(CEA-R-3179)

A method is described for O_2 self-diffusion profile determination in solid UO_2 samples, with a possible extension to other refractory oxides. A thin (10 to 20 microns) layer of enriched oxide $U^{18}O_2$ ($^{18}O/^{18}O+^{18}O=75\%$) is allowed to diffuse into a semi-infinite medium of natural UO_2; upon grinding successive layers of definite thickness, the isotope concentration ratio is determined by spark-source mass-spectrometric analysis on the surface of the massive sample. The spark trace does not exceed a depth of 10 microns and the diffusion zone covers more than 50 microns, corresponding to a variation of the concentration ratio larger than 100. This method gave values for self-diffusion of $(1.3\pm0.2)\times10^{-10}$ and $(3.4\pm0.9)\times10^{-10}$ cm^2/sec for 2 experiments at 1020°C. Author (NSA)

N67-39284# New York Univ., N. Y. Dept. of Aeronautics and Astronautics.
CREEP CHARACTERISTICS OF POLYETHYLENE FILM
Harold Alexander *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 19–38 refs (See N67-39261 23-02)
(Contract AF 19(628)-4990)

In order to find the constitutive relations for polyethylene balloon film, an experimental investigation was conducted in which samples of polyethylene film were loaded both uniaxially and biaxially. The results of this investigation are presented as creep curves for strain versus time at constant true stress. The characteristics of these graphs are then discussed. Author

N67-39285# New York Univ., N. Y. Dept. of Aeronautics and Astronautics.
EXPERIMENTAL STUDY OF BALLOON MATERIAL FAILURES
Arnold D. Kerr *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 39–47 refs (See N67-39261 23-02)
(Contract AF 19(628)-4990)

Results of neoprene and polyethylene film tests conducted in the past year are presented with an emphasis on findings related to balloon failures. Planned tests to study fatigue failures of balloon materials at low temperatures are also described. Author

N67-39272# Hauser Research and Engineering Co., Boulder, Colo.
ROUND ROBIN COLD BRITTLENESS TESTS OF BALLOON FILMS
Ray L. Hauser *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 125–132 (See N67-39261 23-02)

The program comparing the effects of the incline plane and straight drop impact tests at −80°C is reported. In both cases a 1-lb, 2-in. diameter ball is used to break the film. The inclined plane has a 60° slope which curves into a horizontal chute after a 36-inch descent. In the drop test the ball is dropped in free fall for 27 inches. The data are presented in tabular form and are discussed. It is concluded that the two tests are not equivalent, and that the drop test is more severe. Cupping of the film was found to have no significant effect in the inclined test. A quantitative measure of cold brittleness including discrimination for brittleness and ductility is proposed. N.E.N.

N67-39274# Winzen Research, Inc., Minneapolis, Minn.
BALLOON MATERIALS
D. R. Williams and Jean R. Nelson *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 143–149 (See N67-39261 23-02)

The performance and properties of StratoFilm K and StratoFilm W are discussed. It is reported that only 9.3% failed during the past year, and that failure analysis indicates random results. Failures at or near the tropopause are also investigated. Factors which could result in actual or apparent altitude deficiency in the Arctic atmosphere operation are identified as due to the barotransmitter recording which gives a lower pressure reading in the higher temperature environment, and to temperature effects on actual density altitude when the balloon does not reach full inflation. Film temperature characteristics were obtained. It was concluded that there was no significant difference in stabilized radiation temperature characteristics between the StratoFilms, polyurethane, and nylon films. N.E.N.

N67-39307# United Kingdom Atomic Energy Authority, Harwell (England). Metallurgy Div.
WETTING OF ALUMINIUM OXIDE AND OTHER OXIDES BY LIQUID METALS: BIBLIOGRAPHY
P. J. Jones, comp. May 1967 10 p refs
(AERE-BIB-155) CFSTI: HC $3.00/MF $0.65

A bibliography of 66 references is presented. Sources are Chemical Abstracts, Nuclear Science Abstracts, Scientific and Technical Aerospace Reports, and British Ceramics Abstracts. NSA

19 MATHEMATICS

Includes calculation methods and theory; and numerical analysis. For applications see: 08 Computers.

N67-38061 California Univ., Berkeley. Operations Research Center.
NOTES ON OPERATIONS RESEARCH—6
May 1967 114 p refs
(Grant NSF GP-7417)
(ORC-67-17)

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1. A NOTE ON DIVISIBLE ACTIVITIES IN CRITICAL PATH ANALYSIS L. D. Bodin 6 p refs (See N67-38062 23-19)

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7. EXTREMAL PROBLEMS IN QUEUING THEORY G. P. Klimov 29 p refs (See N67-38068 23-19)

N67-38062 California Univ., Berkeley. Operations Research Center.
A NOTE ON DIVISIBILITY ACTIVITIES IN CRITICAL PATH ANALYSIS

Lawrence D. Bodin *In its* Notes on Operations Res.—6 May 1967 6 p refs (See N67-38061 23-19)

An alternate method of solving the divisible activity problem is discussed. Constraints are added to make the original alternate primal formulation a special case of the cost–time project scheduling problem. This redefinition permits the divisible activity problem to be solved by an algorithm already developed for solving the cost–time project scheduling problem. N.E.N.

N67-38063 California Univ., Berkeley. Operations Research Center.

A NONLINEAR NONCONVEX PROGRAMMING PROBLEM

L. D. Bodin, S. C. Parikh, and R. Rangarajan *In its* Notes on Operations Res.—6 May 1967 8 p refs (See N67-38061 23-19)

A method is presented of solving the problem using the principle of optimality of dynamic programming. Examples are given of applications in reliability theory and economics. N.E.N.

N67-38064 California Univ., Berkeley. Operations Research Center.

AN ALGORITHM FOR A MACHINE LOADING PROBLEM

C. R. Glassey *In its* Notes on Operations Res.—6 May 1967 17 p refs (See N67-38061 23-19)

A network flow model is formulated for a manufacturing process in which the operations must be performed in a fixed sequence. The sequencing problem is solved by using the decomposition principal of linear programming, with an algorithm for finding the shortest route through a network. An example is presented, and the extension to multiple product problems is discussed. N.E.N.

N67-38065 California Univ., Berkeley. Operations Research Center.

A NOTE ON NONPLANAR NETWORKS AND COHERENT STRUCTURES

Robert Harris *In its* Notes on Operations Res.—6 May 1967 6 p refs (See N67-38061 23-19)

The topological dual notion is extended beyond planar networks considering an undirected network as a special case of a dual coherent structure. Properties of coherent structures are reviewed. It is shown that duality can be made to rest on a (1–1) correspondence between paths and cuts, and nonplanar networks are characterized. The equivalence of maximum flow and shortest route problems is described. N.E.N.

N67-38066 California Univ., Berkeley. Operations Research Center.

ON GENERALIZED UPPER BOUNDED TECHNIQUES FOR LINEAR PROGRAMMING

Arnoldo Hax *In its* Notes on Operations Res.—6 May 1967 25 p refs (See N67-38061 23-19)

An algorithm based on a variation of a compact basis triangularization method, and requiring only row transformations to be effective, is presented. Details are given on the row transformation approach. A column approach is developed to compare the efficiencies of the variation and the earlier methods. It is concluded that the two methods are equivalent, but that the variation presented here may contribute to a better understanding of the generalized upper bounding technique. N.E.N.

N67-38067 California Univ., Berkeley. Operations Research Center.

COMPARISON OF THE PRIMAL, DUAL, AND PRIMAL–DUAL DECOMPOSITION ALGORITHMS

Stephen Jacobsen *In its* Notes on Operations Res.—6 May 1967 14 p refs (See N67-38061 23-19)

The comparison is made on the basis of the practical advantage of primal feasibility, the usefulness of generated information, and the relative number of returns to the subproblems. Details are given on the primal, dual, and primal–dual decompositions. It is concluded that: (1) The primal method generates extra useful information easily. (2) Both dual methods imply the problem is not feasible until termination, and therefore both procedures must be carried out until an optimal solution is achieved. (3) Visits to the subproblems may be more frequent when using either dual method. (4) A post-optimal routine will be required when using either dual method in the case of unbounded constraint sets. N.E.N.

N67-38068 California Univ., Berkeley. Operations Research Center.

EXTREMAL PROBLEMS IN QUEUING THEORY

G. P. Klimov *In its* Notes on Operations Res.—6 May 1967 29 p refs (See N67-38061 23-19)

Problems connected with the selection of optimal control of the feeding in of demands and of their servicing are discussed. The general statement of the problem is set forth, and specific theorems are formulated and proved. Cases are illustrated in which the known quantity is the service rate, the arrival rate, neither rate, and both rates. A discussion on Pontryagin's maximum principle is presented. N.E.N.

N67-38094# Northwestern Univ., Evanston, Ill. Technological Inst.

MATHEMATICAL PROGRAMMING BY GENERALIZED SEQUENTIAL UNCONSTRAINED METHODS

Anthony V. Fiacco Jun. 1967 31 p refs

(Contracts Nonr-1228(10); DA-31-124-ARO(D)-322)

(MEMO-178; AD-656904)

Our objective is to provide a more general theoretical basis for those methods for solving constrained minimization problems that are based on successive unconstrained minimizations of a parametric auxiliary function. In order to do this, we first give basic defining properties of a general auxiliary function and obtain a proof of local convergence for the mildly regulated nonconvex problem. We proceed from this general result to develop a family of auxiliary functions by giving the general function more and more structure, eventually being led to the general form of the penalty functions that conventionally have been utilized. Similarly, the problem structure is increasingly specialized and we deal finally with the convex problem. As expected, stronger results are obtained as additional structure is assumed. Author (TAB)

N67-38122 Naval Ordnance Lab., White Oak, Md.

NUMERICAL INVESTIGATION OF HIGHER ORDER DIFFERENCE METHODS FOR SOLVING ELLIPTIC PARTIAL DIFFERENTIAL EQUATIONS

Don R. Smith and Frederick K. Ullman Jun. 1967 43 p refs

(NOLTR-67-51; AD-656902)

The Dirichlet problem for the Poisson equation delta U = G in a domain D is considered. It has been thought in the past that the use of higher order difference schemes in the approximate solution of such problems is not practical. However, results due to Bramble and Hubbard show that when G is sufficiently smooth, a truncation error of O(h superscript 4) can be obtained by use of a difference scheme which is O(h superscript 4) in the interior but only O(h superscript 2) near the boundary, where h is the mesh spacing. Other results, due to Bramble, Hubbard, and Zlamal, give error estimates when the function G has an isolated singularity in D satisfying certain conditions. In this report, the approximate solution of the preceding Dirichlet problem is carried out for several functions G and for several domains D, with boundary values

such that the solutions are known exactly. The difference schemes used are those for which error estimates were given by the preceding authors. The results show that these error estimates can be very useful in practice, and that it may be more economical in some cases to use a higher order difference scheme together with a larger value of the mesh spacing h. Author (TAB)

N67-38186# Oak Ridge National Lab., Tenn.
LIMIT THEOREMS FOR ADDITIVE-MULTIPLICATIVE RANDOM SEQUENCES
A. S. Paulson and V. R. R. Uppuluri (Ph.D. Thesis—Va. Polytech. Inst.) Jul. 1967 83 p refs
(Contract W-7405-ENG-26)
(ORNL-4144)

The limiting behavior of the vector-valued, additive—multiplicative random sequences $|Y_n|$ defined by the first order stochastic difference equation $Y_n=W_n+X_nY_{n-1}$, where W_n is a random vector and X_n is a random matrix, is investigated. Conditions were provided which imply that the limiting moments of the vector Y_n exist. General conditions which ensure that $|Y_n|$ converge in distribution are given. Theorems related to convergence in distribution of $|Y_n|$ are applicable to certain classes of functional equations and enables the deduction of certain properties of these functional equations. Convergence in probability of $|Y_n|$ is precluded except in trivial situations is proved. Conditions ensuring that the limiting moments of $|Y_n|$ are the moments of the limiting distribution of $|Y_n|$ are given. Necessary and sufficient conditions for the mutural independence among the components of the limiting random vector Y are provided. Author (NSA)

N67-38194# Ballistic Research Labs., Aberdeen Proving Ground, Md.
PATTERN SEPARATION BY LINEAR PROGRAMMING
Malcolm S. Taylor Jul. 1967 12 p refs
(BRL-MR-1856; AD-656928)

The problem of pattern separation, arising in the study of pattern recognition, currently of interest at BRL, is presented and formulated as a problem in linear programming. Some preliminary computational results are noted. Author (TAB)

N67-38263# Syracuse Univ., N. Y. Physics Dept.
GREEN'S THEOREM AND INVARIANT TRANSFORMATIONS
Joshua N. Goldberg Apr. 1967 20 p refs
(Grants AF-AFOSR-789-66; NSF GP-5643)
(AFOSR-67-1644; AD-655964)

Conservation laws are derived with the use of Greens theorem. These are studied specifically for the wave equation. A trivial class of invariant transformations exists which maps solutions into solutions. The mapping consists in the addition of a particular solution to all solutions. Because of the linearity of the wave equation, this sum will again be a solution. It is shown that this class of transformations has the Newman-Penrose constants among its generators. Calculations are carried out explicitly for the scalar wave equation and for Maxwells equations. Author (TAB)

N67-38260# Stanford Univ., Calif. Dept. of Statistics.
A CLASS OF EPSILON BAYES TESTS OF A SIMPLE NULL HYPOTHESIS ON MANY PARAMETERS IN EXPONENTIAL FAMILIES
Carl Morris 13 Jul. 1967 60 p refs
(Contract Nonr-225(72))
(TR-57; AD-656909)

Xi,...,Xk are observed as independent one-dimensional random variables, Xi being the sufficient statistic for a parameter theta i in an exponential family. The problem of testing the hypothesis Ho: theta i = theta oi is considered when k is large. The usual hypothesis testing loss structure and near alternatives for moderate size and power are assumed. If epsilon > 0 is given and k is large enough, it is shown that the Bayes test for a prior distribution pi making the (theta i) independent under Hi has Bayes risk at most epsilon less than a test based on a non-negative definite quadratic form which rejects Ho when summation (aiXi + bi(Xi squared)) = or > c. The constants (ai) and (bi) are determined by the first two moments of (theta i) under pi, reducing the class of decision procedures under consideration. The approximate Bayes risk and location of the prior distribution under pi is determined. The quadratic forms are shown to be proper Bayes for fixed k. For large k, epsilon-minimax tests are determined. Applications of the above results are made to the binomial, negative binomial, Poisson, normal and gamma distributions by introducing the concept of quadratic moment structure. Some large deviation theorems are proved for exponential families. Author (TAB)

N67-38279* National Aeronautics and Space Administration, Washington, D. C.
CONVERGENCE IN THE MEAN [SUR LA CONVERGENCE EN MOYENNE]
E. Fischer Oct. 1967 4 p refs Transl. into ENGLISH from Compt. Rend. (Paris), v. 144, Jan.–Jun. 1907 p 1022–1024
(NASA-TT-F-11341) CSCL 12A

A brief exposé on a theorem for orthogonal systems of functions, relative to the convergence in the mean of series, is given to disprove a theorem previously developed by Riesz. The theorem is established and proved that, if a series of functions belonging to Ω converges in the mean, a function f will exist in Ω to which it also converges in the mean. Author

N67-38300# Naval Missile Center, Point Mugu, Calif.
DENSITY FUNCTIONS FOR SOME RANDOM SUMS OF NORMAL, SINUSOIDAL, AND RAYLEIGH VARIABLES
C. O. Archer 9 Aug. 1967 131 p refs
(NMC-TM-67-35; AD-657121)

The sums of random variables having Rayleigh, normal, and sinusoidal probability density functions are investigated. The resulting density function of the sum is given and the effect of adding random variables in various ratios is analyzed by studying the resulting density functions through their graphs. In the appendix, derivations of the density functions are shown. Author (TAB)

N67-38323# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
ON THE CONTINUITY OF A NONLINEAR INTEGRAL OPERATOR
P. P. Zabreiko 26 May 1967 8 p refs Transl. into ENGLISH from Sibirskiy Mat. Zh. (Moscow), v. 5, no. 4, 1964 p 958–960
(Contract NOw-62-0604-c)
(TG-230-T525; TT-67-62664; AD-657162)

Let G and G° be bounded closed regions in R superscript n; let K(t,s,u) and S(t,s,u) carry G° x G x R into R and satisfy the Caratheodory conditions: measurable in t and s for all u, and continuous in u for almost all t,s. The author gives a majorization criterion for continuity and definition everywhere of the Urysohn operator Kx(t) = the integral taken over G of K(t,s,x(s)) ds. TAB

N67-38348* National Aeronautics and Space Administration, Washington, D. C.
ON SYSTEMS OF ORTHOGONAL FUNCTIONS [UBER ORTHOGONALE FUNKTIONENSYSTEME]

F. Riesz Oct. 1967 7 p refs Transl. into ENGLISH from Mathematisch-Physikalische Klasse (Gottingen), v. 1, 1907 p 117–121
(NASA-TT-F-11343) CSCL 12A

Hilbert's general method for the solution of linear integral equations, in which the solution is reduced to the solution of a system of linear equations with infinitely many unknowns over an orthogonal function system, is modified to define the conditions under which a function exists such that, for each function of the orthogonal system, the integral of the product of this function with the function in question yields the coordinate number. The theorem is extended to orthogonal systems of functions of one or several variables defined for any measurable point set. Author

N67-38423*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
GENERALIZED DECOMPOSTION THEORY OF FINITE SEQUENTIAL MACHINES
H. Allen Curtis Washington, NASA, Oct. 1967 48 p refs
(NASA-TN-D-4108) CFSTI: HC $3.00/MF $0.65 CSCL 09B

As a direct outgrowth of a study of the decomposition structure of finite sequential machines, an extended decompostion theory of finite sequential machines is developed and presented in this report. From the theory it can be determined how any finite sequential machine can be realized from a set of smaller, concurrently operating machines. This ability assumes practical significance in problems vital to the further advancement of space science, such as the design of control systems and of data gathering and data analyzing systems. Author

N67-38437# European Space Vehicle Launcher Development Organization, Paris (France).
ON PONTRYAGIN'S PRINCIPLE
E. Cambi Aug. 1967 46 p refs
(ELDO-TM-103) CFSTI: HC $3.00/MF $0.65

A mathematical model of a problem of optimal control is presented and symbols and conventions are introduced. The statement and the reduced proof of Pontrysgin's principle and of its first consequences are analyzed and some examples are given. Author (ESRO)

N67-38454# Institute for Defense Analyses, Arlington, Va. Research and Engineering Support Div.
DATA SMOOTHING AND TREND ESTIMATION
Robert D. Turner Aug. 1967 40 p refs
(Contract DAHC15-67-C-0011)
(P-324; IDA/HQ-67-5917; AD-657165)

Explicit formulas are presented for estimating position, velocity, and acceleration in low-order polynomial trends, based on least-squares smoothing of sampled data accompanied by statistically uncorrelated measurement errors. Formulas are also given for interpolation and prediction of position and velocity. Expressions for the variances and covariances of consistent position, velocity, and acceleration estimates are given, and the systematic errors accruing from use of a trend estimation basis which is one order lower than the actual trend are presented. One interesting result is that the normalized correlation between the errors in an estimate of current position and those in an estimate of current velocity approaches (1/2) (the square root of 3) when the number of measurements in the estimates becomes large. Finally, the problem of implementing real-time least-squares estimation and prediction formulas in practical systems is discussed. It is concluded that arithmetic execution time requirements can be relaxed by generating certain sums recursively, and that data storage requirements can frequently be eased by collapsing the raw data into short-term-average samples. Author (TAB)

N67-38462# Battelle Memorial Inst., Columbus, Ohio.
SOME UNIFYING CONCEPTS IN RELIABILITY PHYSICS, MATHEMATICAL MODELS, AND STATISTICS
Ralph E. Thomas *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 1–17 refs (See N67-38461 23-09)

The basic concepts of dimensional analysis are used to make a general examination of reliability physics, mathematical models, and statistics. Beginning with reliability physics, an examination of Eyring's equation is made using Buckingham's Pi theorem. The Arrhenius equation is then seen to be an approximation to the Eyring equation. The use of dimensional analysis in constructing mathematical models based on empirical investigations is considered. The appropriate dimensionless variables are first identified, and then are used in experimental exploration and for subsequent mathematical modeling. The probability density functions of statistics may be associated with patterns of "noise." Statistical methods are used for extracting signals from a pattern of noise and for judging the statistical significance of the signal-to-noise ratio. Author

N67-38498# Weibull (Waloddi), Lusanne (Switzerland).
ESTIMATION OF PARAMETERS FROM LARGE SAMPLES ARBITRARILY CENSORED OR TRUNCATED
Waloddi Weibull Wright-Patterson AFB, Ohio, AF Mater. Lab., Jun. 1967 23 p refs
(Contract AF 61(052)-943)
(AFML-TR-67-197; SR-5; AD-657318)

Approximation formulas for the expected values, variances and covariances of the order statistics yi, which provide a very good approximation for sample sizes equal to or larger than N = 20, are developed. Their applications to graphical analysis and parameter estimations by use of desk computing machines and digital computers are demonstrated. Tables which simplify the computing procedure are presented. Author (TAB)

N67-38502# RAND Corp., Santa Monica, Calif.
MAXIMIZING FLOW THROUGH A NETWORK WITH NODE AND ARC CAPACITIES
R. D. Wollmer Jul. 1967 41 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5383-PR; AD-657011)

A method for maximizing the flow from source to destination along a transportation network whose nodes and arcs have limited capacities. An algorithm is derived that eliminates the need for artificial arcs and nodes used in the flow-augmenting method of Fulkerson and Ford. This simplification should provide a substantial savings in computer time and core storage. The problem is formulated as a linear program. For all nodes other than the source and sink, the node capacity may be expressed either as the flow into or out of the node, since these two quantities are equal. For the source and sink, the node capacity must be expressed in terms of the greater of the two quantities. Thus the source node capacity limits flow out of the source, while the sink capacity limits flow into the sink. The solution method used, a cut set approach, is a generalization of Ford and Fulkersons labeling method. Author (TAB)

N67-38544# Maryland Univ., College Park. Fluid Dynamics and Applied Mathematics Inst.
DISCRETE ANALOGS FOR MIXED BOUNDARY VALUE PROBLEMS OF ELLIPTIC TYPE
Vaithilingam Thuraisamy Apr. 1967 178 p refs
(Contract AT(40-1)-3443)
(BN-506; ORO-3443-6) CFSTI: HC $3.00/MF $0.65

The approximate solutions of mixed boundary value problems for the Poisson's and Laplace's equations using finite difference

methods are discussed. The precise formulation of these problems are given. Several finite difference analogs are considered and the rates of covergence of the approximate solutions to the actual solutions are investigated. NSA

N67-38563# RAND Corp., Santa Monica, Calif.
THE KERNEL AND BARGAINING SET FOR CONVEX GAMES
M. Maschler, B. Peleg, and L. S. Shapley Aug. 1967 28 p refs
(Contract F44620-67-C-0045; Proj. RAND)
(RM-5372-PR; AD-657332)

In game theory, a convex game is a competitive situation characterized by increasing marginal utility for coalition membership as coalitions grow larger. The core of any n-person game is the set of outcomes that cannot profitably be blocked by a coalition. For the case of convex games, two other solution concepts--the kernel and the bargaining set--prove to be closely related to the core. The kernel lies in the relative interior of the core, and the bargaining set coincides with the core. RM-4571-PR, which introduced the convex game, showed that the core is similarly related to two other solution concepts: the value solution is the center of gravity of the extreme points of the core, and the Von Neumann-Morgenstern stable set solution coincides with the core. Author (TAB)

N67-38581*# Kent State Univ., Ohio. Dept. of Mathematics.
REPRESENTATION THEOREMS AND WEAK COMPACTNESS
E. Jeffrey Berg Aug. 1967 46 p refs
(Grant NsG-568)
(NASA-CR-89074; TR-24) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Bounded linear transformations of the space C(S,E) into F where S is compact metric space, and E,F are Banach spaces, are examined. An integral representation for the transformations was established. It is shown that where case S is a compact metric space and F is weakly complete, μ takes its values in L(E,F); and the representation is strong. The result is applied to the question of the weak compactness of bounded linear transformations of the space C(S,E) into F, where S is a compact Hausdorff space, and E,F are Banach spaces. L.S.

N67-38583*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
BESSEL FUNCTION SUBROUTINE FOR COMPUTING FUNCTIONS OF THE FIRST KIND $J_N(X)$ OR $J_{N+1/2}(X)$, FUNCTIONS OF THE SECOND KIND $Y_N(X)$ OR $J_{-N-1/2}(X)$, SPHERICAL BESSEL FUNCTIONS $i_N(X)$ OR $y_N(X)$ AND MODIFIED FUNCTIONS $I_N(X)$ OR $K_N(X)$
Thomas E. Michels Sep. 1967 10 p refs
(NASA-TM-X-55935; X-642-67-455) CSCL 12A

A computer subroutine, BSLFNX (FNX,ARG,N,NTYPE), written in IBM 360 Fortran G language, which will compute any one of some given Bessel functions (of the 1st kind, of the 2nd kind, spherical, and modified), is presented. L.S.

N67-38584# New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
THE ONE BODY WIGNER-MOYAL DENSITY FOR A LOCALLY LINEAR POTENTIAL OF ARBITRARY DIMENSION
Jerome K. Percus and John Snygg Jun. 1967 103 p refs
(Contract AT(30-1)-1480)
(NYO-1480-75) CFSTI: HC $3.00/MF $0.65

Using the Wigner-Moyal density and operator techniques, WKB like solutions are obtained in closed form for a system of noninteracting particles in an arbitrary potential of arbitrary dimension. For three dimensions the first three terms of the asymptotic expansion give the Thomas-Fermi approximation with the Weizsäcker correction reduced by 1/9 plus an oscillatory term of amplitude 6 times the reduced Weizsäcker correction. For one dimension the first two terms correspond to a result of Kohn and Sham. Author (NSA)

N67-38595# Joint Publications Research Service, Washington, D. C.
IN DEFENSE OF APPLIED MATHEMATICS
N. Moiseyev *In its* Appl. Math., Computers, and Inform. Models 11 Sep. 1967 p 1-18 (See N67-38594 23-34)

The growing significance of mathematics in technological and scientific development is discussed. A review of the development of computers in the U.S.S.R. is given. Problems for man resulting from the computer are examined; and the role of a group of mathematicians in France grouped together under the name Nikola Burbaki is discussed. L.S.

N67-38647# Bettis Atomic Power Lab., Pittsburgh, Pa.
ELLIPTIC DIFFERENCE EQUATIONS ON A CONVEX DOMAIN
W. H. Guilinger, Jr. and R. B. Kellogg Jul. 1967 26 p refs
(Contracts AT(11-1)-GEN-14; AT(40-1)-3443; Grant NSF GP-3666)
(WAPD-TM-692) CFSTI: HC $3.00/MF $0.65

An elliptic partial differential equation is considered in a convex domain with Dirichlet boundary conditions. For a particular finite difference approximation of the problem in two dimensions, it is shown that the maximum component norm of the discretization error is bounded by a constant times the square root of the mesh spacing. The constant depends on properties of the domain and bounds on third derivatives of the solution. Author (NSA)

N67-38654# Oak Ridge National Lab., Tenn.
EFFECTS OF FAULTY RANDOM NUMBER GENERATORS ON MONTE CARLO CALCULATIONS
Henry A. Feldman 12 Jul. 1967 67 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1625) CFSTI: HC $3.00/MF $0.65

Following Coveyou and MacPherson's estimations of serial correlation in certain uniform random-number generators, an attempt is made to find and measure the influence of this correlation on various random sampling algorithms, used in Monte Carlo calculations, which drew on a uniform generator. Theoretical results concerning some of these algorithms are presented, along with sketchy data on their response to faulty generators. Author (NSA)

N67-38704# Rocky Flats Div., Dow Chemical Co., Golden, Colo.
POLYNOMIAL CURVE FIT BY LEAST SQUARES
Harold E. Clark, Donald C. Coonfield, and Lynn E. Jackson 11 Jul. 1967 10 p refs
(Contract AT(29-1)-1106)
(RFP-968) CFSTI: HC $3.00/MF $0.65

To determine a polynomial approximation to a function by fitting experimentally determined data at a set of discrete points, a Fortran program was set up utilizing an IBM-360 and a CDC-3600 computer. The program, identified as Least, made use of the calculated polynomial to extrapolate the first zero of the function. A measure of fit is calculated and permits the application of three weighting options. Author (NSA)

N67-38780*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
METRIZABILITY AND PATTERN RECOGNITION

Peter Duran Washington, NASA, Oct. 1967 6 p
(NASA-TM-X-1434) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Some attempts are made to apply metric space theory to pattern recognition. The relationship of metrizability to pattern recognition problems are investigated. The number of elements (cardinality) in the set of patterns also has a strong bearing on the ability to use metric concepts in classification of the patterns. The relationship of cardinality to metrizability is discussed. Author

N67-38805# Sandia Corp., Albuquerque, N. Mex.
THE POISSON APPROXIMATION TO THE BINOMIAL AS A RELATION BETWEEN THE PERCENT POINTS OF THE BETA AND GAMMA DISTRIBUTIONS
G. P. Steck [1967] 11 p Presented at the 36th Session of Intern. Statist. Inst., Sydney
(Contract AT(29-1)-789)
(SC-DC-67-1788; CONF-670809-1) CFSTI: HC $3.00/MF $0.65

Two series relating the percentiles of the beta distribution, the percentiles of a related chi-square distribution, and the binomial sample-size parameter required for a given cumulative binomial sum are obtained from an expansion of a real double integral. The four other possible expressions relating these three quantities, each expanded in powers of each of the others, are derived. The motivation throughout is to have equality between cumulative binomial and Poisson sums. NSA

N67-38831* National Aeronautics and Space Administration, Washington, D. C.
ON ORTHOGONAL SYSTEMS OF FUNCTIONS [SUR LES SYSTEMES ORTHOGONAUX DE FONCTIONS]
F. Riesz Oct. 1967 5 p refs Transl. into ENGLISH from Compt. Rend. Hebd. Acad. Sci. (France), v. 144, Jan.–Jun. 1907 p 615–619
(NASA-TT-F-11342) CSCL 12A

Hilbert's general method for solving certain functional equations by means of an infinite system of linear equations with an infinite number of unknowns, is extended by defining the conditions under which a function exists such that, for each function of the system, the integral of the product of this function and of the function in question taken over the interval is equal to the prescribed number. The theorem is established and proved for definite functions in the interval 0 to 2π, and applicability to the case of an arbitrary interval is demonstrated. Author

N67-38946*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE REDUCTION OF THE SOLUTION OF A GAME OF PURSUIT FOR SURVIVAL PAYOFF TO THE SOLUTION OF A COUCHY PROBLEM FOR A FIRST ORDER PARTIAL DIFFERENTIAL EQUATION
L. A. Petrosyan Redstone Arsenal, Ala., Redstone Sci. Inform. Center, 1 Jun. 1966 8 p refs Transl. into ENGLISH from Dokl. Akad. Nauk Arm. SSR (Erevan), v. 40, no. 4, 1965 p 193–196
Prepared jointly with Army Missile Command
(NASA-TM-X-60396; RSIC-565) CFSTI: HC $3.00/MF $0.65 CSCL 12A

The solution of the Couchy problem for a general, quasilinear equation in partial derivatives of the first order can be found by the Couchy method. Given are specific conditions for the manifold and functions where this solution exists. In several concrete problems of pursuit for survival, the existence and a constant differentiation of the game function value come from theoretical game calculations. According to the theorem, a solution of the Couchy problem exists and is used for locating the game value and the optimal strategies for different games. Author

N67-38999 Joint Publications Research Service, Washington, D. C.
ALGORITHM FOR THE APPROXIMATE SOLUTION OF A RESOURCE DISTRIBUTION PROBLEM IN NETWORK PLANNING
L. Ya. Leyfman 9 Oct. 1967 6 p ref Transl. into ENGLISH from Dokl. Akad. Nauk SSSR (Moscow), v. 175, no. 2, 1967 p 306–308
(JPRS-42893; TT-67-33519) CFSTI: $3.00

A previously formulated distribution problem and its algorithm are studied. The data are fed in the form of a topologically ordered activity list and calendar. The process is described for partitioning the activity list into groups for which the values are simultaneously selected. Scheduling for the next subclass is also covered. N.E.N.

N67-39030 Joint Publications Research Service, Washington, D. C.
DUAL PROBLEMS IN CONVEX AND CONVEX-FRACTIONAL PROGRAMMING IN FUNCTIONAL SPACES [DVOYSTVENNYYE ZADACHI VYPUKLOGO I DROBNOVYPUKLOGO PROGRAMMIROVANIYA V FUNKTSIONAL'NYKH PROSTRANSTVAKH]
Ye. G. Gol'shteyn 5 Oct. 1967 13 p refs Transl. into ENGLISH from Russian
(JPRS-42840; TT-67-33466) CFSTI: $3.00

A general plan for formation of the dual problem for functional analogs of the problems of convex and convex-fractional programming is proposed. A number of statements are formulated, creating a basis for dual theory for these problems. The proposed plan for setting up the dual problem is analytical in nature and generalizes the approach for finite problems of convex programming. Author

N67-39149# California Univ., Berkeley. Operations Research Center.
GENERALIZED STOCHASTIC PROGRAMS WITH DETERMINISTIC RECOURSE
Shailendra C. Parikh Jul. 1967 84 p refs
(Grant NSF GP-7417)
(ORC-67-27)

The formulation of the two-stage linear program under uncertainty or the stochastic linear program arises naturally when the demands are probabilistic. A solution approach to such problems is the cutting-plane method. An approximate-cutting-plane method is introduced as a replacement. It is further shown that when the decomposition principle of linear is used to solve the second-stage problems, it is not necessary to reach optimality. Computations can instead be terminated short of optimality in which case one can obtain an approximate-cutting-plane which can be used to apply the approximate-cutting-plane method to solve generalized stochastic programming problems. Finally, it is shown that the degree of approximation of the final solution which is attained in a finite number of steps equals that of the approximate-cutting-planes. Author

N67-39204# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
ORDER-PRESERVING FUNCTIONS; APPLICATIONS TO MAJORIZATION AND ORDER STATISTICS
A. W. Marshall, D. W. Walkup, and R. J.-B. Wets Dec. 1966 29 p refs Its Math. Note No. 493
(DI-82-0583)

Let $\leq$ be a partial ordering among the points of a set $D \subset R^n$. A real-valued function f defined on D is said to preserve $\leq$ if $x,y \in D$, $x \leq y$ implies $f(x) \leq f(y)$. The central theorem of this paper gives necessary and sufficient conditions for f to preserve

$\leq$ if $\leq$ is a cone ordering, i.e. if there exists a convex cone C such that $x \leq y$ if and only if $y - x \in C$. Corollaries to the theorem consider the case when f is differentiable and $\leq$ is order isomorphic to a cone ordering under a differentiable mapping. It is seen that the ordering of majorization is a special case of a cone ordering and that a straightforward application of a corollary yields the results of Schur and Ostrowski on functions which preserve majorization. The corollaries are also applied to a partial ordering of positive semi-definite matrices and to certain partial orderings arising in the theory of order statistics. Author

N67-39249* Brown Univ., Providence, R. I. Center for Dynamical Systems.

ON VOLTERRA INTEGRAL EQUATIONS WITH NONNEGATIVE INTEGRABLE RESOLVENTS

R. K. Miller [1966] 39 p refs

(Grants NGR-40-002-015; AF-AFOSR-693-67)

(NASA-CR-89076) CSCL 12A

A mathematical discussion is presented on the solution and behavior of certain linear and nonlinear equations, and the proofs of the theorems are given. N.E.N.

N67-39298# Oregon Univ., Eugene.

ON ALGEBRAS OF FINITE REPRESENTATION TYPE Final Technical Report

Spencer E. Dickson 31 Aug. 1967 35 p refs

(Contract N00014-66-C0293)

(AD-657251)

This paper launches a new attack on the Brauer-Thrall conjecture that bounded representation type implies finite representation type for algebras by showing the relevance of the structure of indecomposables of certain special types, namely the stable (every maximal submodule is indecomposable), the costable (having the dual property), and the stable-costable indecomposable modules (having both properties). We give sufficient conditions on the structure of the stable (resp. costable, stable-costable) indecomposables in order that the algebra will have at most finitely many isomorphism classes of modules of any finite composition length. Turning our attention to quasifrobenius algebras with large kernels (i.e., satisfying the condition that a nilpotent endomorphism of any indecomposable of finite length has large (or essential) kernel) we give somewhat sharper conditions that bounded type implies finite type for these algebras and make a contribution toward an open question of Curtis and Jans. An algebra has large kernels in particular when every indecomposable has square-free socle, which was the main hypothesis of the cited paper of Curtis and Jans. TAB

N67-39364*# Illinois Univ., Urbana. Electrical Engineering Research Lab.

COMPUTER METHODS FOR SOLVING A DIFFUSION BOUNDARY VALUE PROBLEM

V. S. Gylys Sep. 1967 35 p refs

(Grants NsG-24; NSF GP-411)

(NASA-CR-89279; TR-32) CFSTI: HC $3.00/MF $0.65 CSCL 12A

Three finite difference methods and a computer program for a boundary value problem, which models the density of electrons in the ionosphere, are described. A backward difference method, a central difference method based on three time levels, and the Crank–Nicolson methods are discussed. It is pointed out that each method leads to the same system of linear equations. The input parameters, coefficients and boundary conditions are covered, and the usage of the program is mentioned. N.E.N.

N67-39369# General Electric Co., Philadelphia, Pa. Missile and Space Div.

PATHS CONNECTING ELEMENTARY CRITICAL POINTS OF DYNAMICAL SYSTEMS

Paul Gordon Sep. 1967 271 p refs

(R67SD26)

This report is concerned with the occurrence of solution paths connecting elementary critical points of systems of autonomous ordinary differential equations. Since such paths can be thought of as being formed by the intersection of two manifolds, part of the problem is very much a geometric one. Section I deals with this aspect. The major result is Theorem 2, which gives conditions insuring that the connecting paths are persistent under perturbation. A simple equation, relating the dimension of the manifolds to the dimension of the intersection, is also derived. Sections II and III are primarily concerned with defining situations where this equation is satisfied. Section IV contains one of the major results, Theorem 8. This theorem insures the existence of a stable path connecting two elementary critical points. Section V has as its primary goal the application of Theorem 8 to practical physical problems. Various papers that have appeared in the literature are discussed. Also, new work on the Shock Structure problem is presented. Under suitable assumptions the existence of a locally unique, stable solution is exhibited. Author

20 METEOROLOGY

Includes climatology; weather forecasting; and visibility studies. For related information see also: 13 Geophysics; and 30 Space Sciences.

N67-38210*# Israel Program for Scientific Translations, Ltd., Jerusalem.

ATMOSPHERIC-DENSITY EFFECTS IN THE EAS FREQUENCY DURING CYCLONES AND SEASONAL FLUCTUATIONS IN ATMOSPHERIC TEMPERATURE

D. D. Krasil'nikov, M. M. Atakova, N. N. Efinov, M. A. Nifontov, and F. K. Shamsutdinova *In its* Cosmi Rays and Probl. of Space Phys. 1967 p 112–117 refs (See N67-38201 23-29)

Preliminary results of studies on cosmic ray showers during passage of 17 cyclones through Yakutsk during 1958 and 1959 are reported. Graphs are presented of mean variations in atmospheric pressure and temperature, and of mean variations of shower frequency. Corrections for barometric and geometric effects were introduced, and the errors in the corrections were found not to be responsible for the variations in shower frequency. The results are summarized as follows: (1) The geometric density effect on shower frequency of atmospheric layer above the 300 mB level was found to be 1.5 to 2 times the effect expected for the lower layers. (2) Data were obtained indicating that decaying particles have considerable effect on sea level shower frequency. (3) The short range cascade model does not explain the atmospheric density effect. N.E.N.

N67-38286# San Fernando Valley State Coll., Northridge, Calif.

CLIMATIC NORMALS AS PREDICTORS. PART I: BACKGROUND

Arnold Court 1 May 1967 40 p refs

(Contract AF 19(628)-5716)

(AFCRL 67-0313; Rept.-82-67-1; SR-1; AD-657358)

Preliminary to investigating the length of the climatic period whose average gives the best (minimum variance) estimate of the next years value, previous studies are examined and the results of five are replotted onto a standard scale. All indicate that prediction one year ahead from an average based on only 20 years, or so,

is better than one from a standard climatic normal of 30 years. Monte Carlo simulation of the prediction process suggests that slight changes with time in the means, whether real or caused by instrumental or observational changes, in most climatic records reduce the record length for optimum prediction. Author (TAB)

N67-38293 Finnish Meteorological Office, Helsinki.
BUDGET OF KINETIC ENERGY IN A DEVELOPING EXTRATROPICAL CYCLONE
Heikki Pennanen 1966 24 p refs
(Rept.-64)

For a selected synoptic situation characterized by a deepening cyclone over the northwestern parts of Europe, the fields of divergence and vertical velocity were determined from the horizontal wind field at different levels. The results were used for computing the rate of conversion between potential and kinetic energy. For the same region also the net flux of kinetic energy across the horizontal and vertical boundaries, the work done by pressure forces, and the dissipation of energy due to friction were estimated. Author

N67-38388# Weather Bureau, New York.
USE OF REFLECTIVITY MEASUREMENTS AND REFLECTIVITY PROFILES FOR DETERMINING SEVERE STORMS
Robert E. Hamilton Oct. 1966 14 p refs
(TM-17)

Radar reflectivity measurement techniques for distinguishing hail storms and tornadoes from ordinary rainstorms are reviewed. Results obtained using 3-cm and 10-cm radars are evaluated and consideration is given to reflectivity maxima aloft measurement differences between the two equipments. Equations for computing certain reflectivity values are shown. It is mentioned that storms containing large amounts of hail frequently display reflectivity maxima aloft, usually at about 20,000 feet for the 10-cm radar and 20,000 to 25,000 feet for the 3-cm radar. Reflectivity maxima aloft occurs with both 3-cm and 10-cm radars during surface hail storms. The 3-cm radar normally depicts a more sharply defined maxima aloft than the 10-cm radar. E.C.

N67-38504# Weather Wing (2nd), APO 332, New York.
A STUDY OF PERSISTENT AND WIDESPREAD FOG PERIODS IN SOUTHERN GERMANY
Willi Laun Aug. 1967 25 p
(Rept.-2YS-422; AD-657088)

The study discusses 10 cases of widespread heavy fog occurring over the southern half of Germany during the October to March periods of the years 1958 to 1961. The general surface and 500 MB synoptic situations attending fog formations are discuseed and charts are included. Author (TAB)

N67-38538# Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXII, NO. 1: COMPARISON BETWEEN ESTIMATES OF AVERAGE WIND VELOCITY, MAXIMUM WIND GUSTS, AND THE GRADIENT WIND [METEOROLOGISCHEN ABHANDLUNGEN. BAND LXXII, HEFT 1: VERGLEICH ZWISCHEN WINDSCHAETZUNGEN, DEN MITTLEREN WINDGESCHWINDIGKEITEN, MAXIMALBOEEN UND DEM GRADIENTWIND]
Renate Stuhrmann 1967 53 p refs In GERMAN, ENGLISH summary
CFSTI: HC $3.00/MF $0.65

Structure of the surface wind and associated problems are surveyed. By means of a literature index, the difficulties in measurement of the wind velocity and the estimates of the wind force at sea are examined. It was necessary to determine new velocity equivalents of the Beaufort-Scale at sea. As the problems of the relation of estimated wind force and measured wind velocity of inland stations are different from those at sea, the estimated wind forces of a climatologic station were compared with the measured mean wind velocities and maximum gusts at the Meteorological Institute, both stations being situated at Berlin-Dahlem, over a period of ten years. Wind estimates are between the measured wind velocity and the present maximum values. A relation between the maximum gusts at the surface and the gradient wind is given for 1000 and 1500 m; and during favorable weather situations, the upper air wind can be considered at these levels for determining the maximum gusts at the surface. Author

N67-38550# Army Cold Regions Research and Engineering Lab., Hanover, N. H.
SURVEY OF FROZEN PRECIPITATION IN URBAN AREAS AS RELATED TO CLIMATIC CONDITIONS
Michael A. Bilello May 1967 37 p
(CRREL-TR-162; AD-657212)

The study investigates relationships between observed frozen precipitation and associated meteorological conditions in large cities, and develops procedures for presenting tabulated data on frozen precipitation in a readable and usable form. An explanation of several interpretations is included with methods of analysis, sample diagrams, advantages and disadvantages, and comparisons of the different interpretations. To avoid excessive bulk, only the diagrams for LaGuardia Airport and Buffalo, New York, are discussed in this paper. Similar Figures for 22 other stations are on file at USA CRREL. Author (TAB)

N67-38554 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXIX, NO. 5: DAILY AND AVERAGE SURFACE AND 850 MB MAPS OF THE NORTHERN HEMISPHERE, MAY 1967 [METEOROLOGISCHEN ABHANDLUNG. BAND LXXIX, HEFT 5: TAEGLICHE UND MITTLERE BODEN- UND 850-MB-KARTEN DER NORDHEMISPHAERE IM JAHRE 1967, MAI]
Richard Scherhag et al 1967 82 p In GERMAN

The May 1967 world weather situation summary is presented in addition to the following: (1) daily and mean 850-mb charts of the Northern Hemisphere, 00 GMT; and (2) daily and mean ground charts of the Northern Hemisphere, 12 GMT. The charts cover the period 1-31 May, 1967 Transl. by K.W.

N67-38555 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 3: RESULTS OF THE SYNOPTIC SERVICE, MARCH 1967 [METEOROLOGISCHE ABHANDLUNG. BAND LXXVIII, HEFT 3: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, MAERZ]
Richard Scherhag et al 1967 201 p refs In GERMAN

This volume contains: (1) weather charts for Berlin, Germany for the period 1-30 March, 1967; (2) charts and tables of climatological temperature, precipitation, and radioactivity data for Berlin, Germany for March 1967; (3) snow and ice data for Germany for March 1967; and (4) articles and charts concerning storm activities in the North Sea, radioactivity resulting from Chinese atom bomb tests, record-low temperatures in the Arctic, and the meteorology of tropical Africa. Transl. by K.W.

N67-38590 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVI, NO. 5: RESULTS OF THE RADIOSONDE STATION ASCENTS OF THE INSTITUT FUER METEOROLOGIE UND GEOPHYSIK OF THE FREIE UNIVERSITAET BERLIN, MAY 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVI, HEFT 5: ERGEBNISSE DER AUFSTIEGE DER RADIOSONDENSTATION DES INSTITUTS FUER METEOROLOGIE UND GEOPHYSIK DER FREIEN UNIVERSITAET BERLIN IM JAHRE 1967, APRIL]
Richard Scherhag et al 1967 85 p In GERMAN; ENGLISH summary

The detailed results of the radiosonde ascents performed by the aerological station of the Institut fur Meteorologie and Geophysik der Freien Universitat Berlin are presented. Extreme and mean values of the temperature, geopotential, pressure, wind data, refractivity, density, pseudopotential temperature and velocity of sound for all standard pressure surfaces and for several height levels, the tropopause and the freezing level were extracted. Author

N67-38599 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXIX, NO. 6: DAILY AND AVERAGE SURFACE AND 850 MB MAPS OF THE NORTHERN HEMISPHERE, JUNE 1967 [METEOROLOGISCHE ABHANDLUNG. BAND LXXIX, HEFT 6: TAEGLICHE UND MITTLERE BODEN- UND 850-MB-KARTEN DER NORDHEMISPHAERE IM JAHRE 1967, JUNI]
Richard Scherhag et al 1967 80 p In GERMAN

A summary of the world weather situation for June 1967 is given in addition to the following: (1) daily and mean 850-mb charts of the Northern Hemisphere, 00 GMT; and (2) daily and mean ground charts of the Northern Hemisphere, 12 GMT. The charts cover the period 1–30 June, 1967. Transl. by K.W.

N67-38600 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVI, NO. 4: RESULTS OF THE RADIOSONDE STATION ASCENTS OF THE INSTITUT FUER METEOROLOGIE UND GEOPHYSIK OF THE FREIE UNIVERSITAET BERLIN, APRIL 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVI, HEFT 4: ERGEBNISSE DER AUFSTIEGE DER RADIOSONDENSTATION DES INSTITUTS FUER METEOROLOGIE UND GEOPHYSIK DER FREIEN UNIVERSITAET BERLIN IM JAHRE 1967, APRIL]
Richard Scherhag et al 1967 95 p In GERMAN; ENGLISH summary

Results of all daily radiosonde measurements performed during April 1967 at the aerological station of this facility are presented, and climatological tables are given. In addition, the following were extracted from the results: extreme and mean values of the temperature, geopotential, pressure, wind data, refractivity, density, pseudopotential temperature and velocity of sound for all standard pressure surfaces and for several height levels, the tropopause, and the freezing level. Author

N67-38601 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXIX, NO. 3: DAILY AND AVERAGE SURFACE AND 850 MB MAPS OF THE NORTHERN HEMISPHERE, MARCH 1967 [METEOROLOGISCHE ABHANDLUNG. BAND LXXIX, HEFT 3: TAEGLICHE UND MITTLERE BODEN- UND 850-MB-KARTEN DER NORDHEMISPHAERE IM JAHRE 1967 MAERZ]
Richard Scherhag et al 1967 86 p In GERMAN

The March 1967 world weather situation is summarized, and the following charts are presented: (1) daily and mean 850-mb charts of the northern hemisphere, 00 GMT; and (2) daily and mean ground charts of the northern hemisphere, 12 GMT. The charts cover the period 1–31 March 1967. Transl. by K.W.

N67-38602 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXV, NO. 2: DAILY ALTITUDE MAPS OF THE 50 MB LAYERS ACCORDING TO MONTHLY MEAN MAPS [METEOROLOGISCHE ABHANDLUNGEN. BAND LXV, HEFT 2: TAEGLICHE HOEHENKARTEN DER 100-MB-FLAECHE SOWIE MONATLICHE MITTELKARTEN FUER DAS JAHR 1966. TEIL II, 2. VIERTELJAHR] Quarterly Report, 1966
Regina Kirch, Barbara Kriester, Karin Labitzke, Richard Scherhag, and Renate Stuhrmann 1966 117 p In GERMAN (QR-2)

This volume contains the following information for the northern hemisphere: (1) remarks on the circulation in the lower stratosphere during the second quarter of 1966; (2) monthly mean, deviation, and change charts of the 100-mb plane for the period March–June 1966; (3) 10-year monthly mean charts of the 100-mb plane for the years 1951–1960, and a comparison with the 5-year mean of the years 1949–1953; and (4) daily high charts of the 100-mb plane, 00 GMT, for April, May, and June, 1966. Transl. by K.W.

N67-38603 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 2: RESULTS OF THE SYNOPTIC SERVICE, FEBRUARY 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVIII, HEFT 2: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, FEBRUAR]
Richard Scherhag et al 1967 112 p refs In GERMAN

The following are presented in this volume: (1) daily weather charts for Berlin, Germany, for February 1967; (2) charts and tables of climatological, temperature, precipitation, and radioactivity data for Berlin, Germany, for February 1967 and the winter 1966/67, and remarks on the world weather situation for the same period; (3) snow and ice data for Germany for February 1967; and (4) articles and charts concerning Polar and Arctic research, hypotheses on electric storms, stratospheric weather and circulations, tropospheric temperatures and weather forecasting, meteorological causes for the sinking of the ship Heraklion, heat budget of the Earth's surface, 1965 tropical cyclones in the Northern Hemisphere, impulse Doppler radar in meteorology, and storms in Berlin, Germany. Transl. by K.W.

N67-38604 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXVI, NO. 2: DAILY ALTITUDE MAPS OF THE 50 MB LAYERS ACCORDING TO MONTHLY MEAN MAPS [METEOROLOGISCHE ABHANDLUNG. BAND LXVI, HEFT 2: TAEGLICHE HOEHENKARTEN DE 50-MB-FLAECHESOWIE MONATLICHE MITTELKARTEN FUER DAS JAHR 1966. TEIL II, 2. VIERTELJAHR] Quarterly Report, 1966
Regina Kirch, Barbara Kriester, Karin Labitzke, Richard Scherhag, and Renate Stuhrmann 1966 106 p In GERMAN (QR-2)

This volume contains the following data for the Northern Hemisphere: (1) remarks on the stratospheric circulation at the 50-mb level during the second quarter of 1966; (2) monthly mean, deviation, and change charts of the 50-mb plane for the period March–June 1966; and (3) daily high charts of the 50-mb plane, 00 GMT, for April, May, and June, 1966. Transl. by K.W.

N67-38606 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXV, NO. 3: DAILY ALTITUDE MAPS OF THE 100 MB LAYERS ACCORDING TO MONTHLY MEAN MAPS [METEOROLOGISCHEN ABHANDLUNG. BAND LXV, HEFT 3: TAEGLICHE HOEHENKARTEN DER 100-MB-FLAECHE SOWIE MONATLICHE MITTELKARTEN FUER DAS JAHRE 1966. TEIL III, 3. VIERTELJAHR] Quarterly Report, 1966
Regina Kirch, Barbara Kriester, Karin Labitzke, Richard Scherhag, and Renate Stuhrmann 1966 115 p In GERMAN
(CR-3)

This volume contains the following data for the northern hemisphere: (1) remarks on the circulation in the lower stratosphere during the third quarter of 1966; (2) monthly mean, deviation, and change charts of the 100-mb plane for the period June–September 1966; (3) 10-year monthly mean charts of the 100-mb plane for the years 1951–1960, and a comparison with the 5-year mean of the years 1949–1953; and (4) daily high charts of the 100-mb plane, 00 GMT, for July, August, and September, 1966. Transl. by K.W.

N67-38801# Wisconsin Univ., Madison. Dept. of Meteorology.
A PHYSICAL-NUMERICAL MODEL FOR INFERRING TROPOSPHERIC STRUCTURE FROM SATELLITE RADIATION MEASUREMENTS. NOTE ON THE RELATIONSHIP BETWEEN TOTAL PRECIPITABLE WATER AND SURFACE DEW POINT. THE CONTRIBUTION OF INFRARED COOLING TO THE VERTICAL MOTION FIELD AND ITS IMPLICATION IN ATMOSPHERIC ENERGETICS Annual Report
William Leo Smith, Ben R. Bullock, Lyle H. Horn, and Donald R. Johnson Dec. 1966 74 p refs
(Grant WBG-52)

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1. A PHYSICAL-NUMERICAL MODEL FOR INFERRING TROPOSPHERIC STRUCTURE FROM SATELLITE RADIATION MEASUREMENTS W. L. Smith p 1–40 refs (See N67-38802 23-20)

2. NOTE ON THE RELATIONSHIP BETWEEN TOTAL PRECIPITABLE WATER AND SURFACE DEW POINT W. L. Smith p 41–42 (See N67-38803 23-20)

3. THE CONTRIBUTION OF INFRARED COOLING TO THE VERTICAL MOTION FIELD AND ITS IMPLICATION IN ATMOSPHERIC ENERGETICS B. R. Bullock, L. H. Horn, and D. R. Johnson p 43–72 refs (See N67-38804 23-20)

N67-38802# Wisconsin Univ., Madison. Dept. of Meteorology.
A PHYSICAL-NUMERICAL MODEL FOR INFERRING TROPOSPHERIC STRUCTURE FROM SATELLITE RADIATION MEASUREMENTS
William Leo Smith *In its* A Phys.-Numerical Model for Inferring Tropospheric Struct. from Satellite Radiation Meas., Note on the Relationship Between Total Precipitable Water and Surface Dew Point, The Contrib. of Infrared Cooling to the Vertical Motion Field and its Implication in Atmospheric Energetics Dec. 1966 p 1–40 refs (See N67-38801 23-20)

A numerical model based on physical considerations is developed which utilizes a set of five radiation measurements over relatively broad spectral intervals (20 cm^{-1} to 40 cm^{-1}) to deduce: (1) surface temperature; (2) lapse rate in the lowest 50 mb; (3) lapse rate above the lowest 50 mb; (4) surface water vapor mixing ratio; and (5) the lapse of moisture with height. Simulated trials indicate that the inferred profiles of temperature and moisture are sufficient to describe the basic qualities of the troposphere from the surface to about 300 mb. The average root mean square temperature errors inherent in the physical modeling are about 2°C. The restraints imposed by the physical modeling are within the resolution of ordinary synoptic analysis of constant pressure level height and moisture fields. Author

N67-38803# Wisconsin Univ., Madison. Dept. of Meteorology.
NOTE ON THE RELATIONSHIP BETWEEN TOTAL PRECIPITABLE WATER AND SURFACE DEW POINT
William Leo Smith *In its* A Phys.-Numerical Model for Inferring Tropospheric Struct. from Satellite Radiation Meas., Note on the Relationship between Total Precipitable Water and Surface Dew Point, The Contrib. of Infrared Cooling to the Vertical Motion Field and its Implication in Atmospheric Energetics Dec. 1966 p 41–42 refs Repr. from J. Appl. Meteorology, v. 5, no. 5, Oct. 1966 p 41–42 (See N67-38801 23-20)

An equation is derived which is of the same form as that obtained statistically by Reitan and Bolsenga with the exception that the A coefficient is not a constant, but a variable which is clearly dependent upon the actual moisture profile. Climatic values of the moisture profile are obtained which will enable good estimates of the total water vapor content to be obtained from the surface dew point regardless of latitude or season. Author

N67-38804# Wisconsin Univ., Madison. Dept. of Meteorology.
THE CONTRIBUTION OF INFRARED COOLING TO THE VERTICAL MOTION FIELD AND ITS IMPLICATION IN ATMOSPHERIC ENERGETICS
Ben R. Bullock, Lyle H. Horn, Donald R. Johnson *In its* A Phys.-Numerical Model for Inferring Atmospheric Struct. from Satellite Radiation Meas., Note on the Relationship Between Total Precipitable Water and Surface Dew Point, The Contrib. of Infrared Cooling to the Vertical Motion Field and its Implication in Atmospheric Energetics Dec. 1966 p 43–72 refs (See N67-38801 23-20)

The validity of the adiabatic assumption used in estimating vertical motion is examined by comparing the relative contributions due to adiabatic processes with the diabatic process of infrared cooling. Radiometersonde data are used to prepare vertical profiles of the adiabatic and infrared components of the vertical motion. These data are first filtered to reduce the effect of random errors. Although the adiabatic component of the vertical motion is usually much larger than the infrared component, the profiles indicate that the infrared component can be important in determining the total vertical motion. A comparison of the contribution of the infrared component in cloudy versus clear sky conditions shows this component to contribute more to downward vertical motion in clear air than in the cloudy situations. The consequences of this systematic variation in estimating energy conversions is discussed. The effect of other diabatic processes is very briefly considered. Author

N67-38839# Colorado State Univ., Fort Collins. Atmospheric Science Dept.
EVIDENCE OF A MESOSCALE WAVE PHENOMENON IN THE LEE OF THE ROCKY MOUNTAINS
R. A. Dirks, J. D. Mahlman, and Elmar R. Reiter Sep. 1967 53 p refs *Its* Atmospheric Sci. Paper No. 115
(Grant E-10-68(G))

Satellite photographs during the summer months frequently reveal a weather situation in which strong convective development is observed over the Rocky Mountains and several hundred kilometers to the east of the mountains, while the region immediately to the lee is essentially cloud free. It is proposed that an orographically induced mesoscale wave phenomenon may produce this situation. A dynamical model is developed which yields standing wave solutions of wavelength <1000 km for conditions of low mean wind speed and low thermal stability. Application of the model to the case of 20–21 July 1966 indicates a reasonable

agreement between observation and theory; however, the sensitivity of the model to input parameters suggests that certain refinements need to be made. Author

N67-39145# McGill Univ., Montreal (Quebec). Dept. of Meteorology.
A STRATOSPHERIC GENERAL CIRCULATION EXPERIMENT INCORPORATING DIABATIC HEATING AND AZONE PHOTOCHEMISTRY
Roland Byron-Scott Apr. 1967 390 p refs *Its* Publ. in Meteorol. No. 87
(Contract AF 19(628)-4955)
(AFCRL-67-0344; SR-4; AD-655058)

A three-level numerical model of the stratosphere is formulated to yield predictions based on the thermodynamic and ozone equations. These latter include long- and short-wave radiation and photochemical ozone production together with eddy diffusion and three-dimensional (geostrophic) advection, the vertical velocity being derived from a quasi-stationary vorticity equation. The model is bounded and forced from below by continuous specification of 70-MB heights and 163 1/3-MB temperatures. Time integrations with moderate, intense and negligible forcing show that: the radiative-photochemical equilibrium state is "unnatural", planetary waves are important transporters of heat and ozone, high-latitude warmings do occur and their intensity depends upon the forcing, and "in situ" warming is mainly due to subsidence. Author (TAB)

N67-39151# Miami Univ., Coral Gables, Fla. Inst. of Marine Sciences.
RADAR HURRICANE RESEARCH Final Report, 1 Sep. 1966–31 Aug. 1967
Harry V. Senn Sep. 1967 46 p refs
(Contract E-22-84-67(N))
(ML-67291)

University of Miami radar operations during hurricane Inez, October 1966, are summarized. The three-dimensional data obtained on the plan-position indicator and the range height indicator are presented along with an analysis of the rapidly changing eye structure, erratic motion, and quantitative aspects of the horizontal and vertical precipitation patterns. In general, tallest echoes tend to return strongest signal intensities; but the Inez precipitation pattern consisted of rather light rain and violated many of the previously suggested indicators of hurricane motion. In an effort to determine the theoretical radio propagation conditions in and around tropical storms, refractive indices were computed for the region below 700 mb from 185 soundings taken in 13 hurricanes and typhoon Marge. The 60 of the soundings which contained layers in which radio waves would be anomalously propagated were classified into subrefractive, superrefractive, and trapping categories. Further subclassification into temperature and/or moisture variations responsible for the theoretical behavior of the radio waves is used in an attempt to explain some of the anomalies. Author

N67-39242 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXIX, NO. 4: DAILY AND AVERAGE SURFACE AND 850 MB MAPS OF THE NORTHERN HEMISPHERE, APRIL 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXIX, HEFT 4: TAEGLICHE UND MITTLERE BODEN- UND 850-MB-KARTEN DER NORDHEMISPHAERE IM JAHRE 1967, APRIL]
Richard Scherhag et al 1967 8 p In GERMAN

This report contains daily and average weather maps for ground and 850 millibar observations of the Northern Hemisphere during April, 1967. Shown are barometric pressures, temperatures, humidity, wind circulation, and ground precipitation.
Transl. by G.G.

N67-39244# Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXII, NO. 4: ON MEASUREMENT METHODS OF SOME RESULTS OF NATURAL RADIOACTIVITY IN THE AIR [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXII, HEFT 4: UEBER MESSMETHODEN UND EINIGE MESSERGEBNISSE DER NATUERLICHEN RADIOAKTIVITAET DER LUFT]
Ernst Ittner 1967 53 p refs In GERMAN; ENGLISH summary

By way of introduction the various radioactive substances are mentioned, especially the relevant atmospheric ones, the radioactive aerosols as well as their occurrence and their behavior in the atmosphere. Some examples of meteorological influence on the amount of natural radioactivity are given. There follows an explanation of the physical bases of emanometry and the different types of emanometers, as far as they are relevant, and another section on modern measuring techniques. Finally information is given about measurements made with H. Israël's emanometer; some of the results are compared with filter measurements carried out simultaneously. The relationship between the simultaneously observed data is discussed. Author

N67-39246 Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXXVIII, NO. 1: RESULTS OF THE SYNOPTIC SERVICE, JANUARY 1967 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXXVIII, HEFT 1: ERGEBNISSE DES SYNOPTISCHEN DIENSTES IM JAHRE 1967, JANUAR]
Richard Scherhag et al 1967 123 p In GERMAN

Presented are the daily weather charts for January, 1967, as well as the monthly and yearly precipitation, pressure, and temperature charts for the Northern Hemisphere obtained during 1931 through 1960. Also included is a brief study on small scale structures in the wind field of the mesosphere. Transl. by G.G.

N67-39278# Air Force Cambridge Research Labs., Bedford, Mass.
MIDALTITUDE STRATOSPHERIC HUMIDITY REGIME TO 30 KM
N. Sissenwine, D. D. Grantham, and H. A. Salmela *In its* Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 185–202 refs
(See N67-39261 23-02)

The results of monthly soundings of humidity up to 25 to 30 km over a year utilizing a highly sophisticated alpha-radiation hygrometer and associated balloon sounding equipment are described. The stratosphere was never found to be near saturation as has been suggested by some investigators, nor was it as dry and completely devoid of variability as is indicated by the most accepted circulation theory. A small minor increase in humidity above the tropopause to altitudes of about 25 km was usually noted. Variability in this region of the lower stratosphere approached a factor of 10. Spasmodic transfer of water vapor upward through the tropopause is suggested and speculation related thereto provided. Author

N67-39302 Environmental Science Services Administration, Asheville, North Carolina. World Data Center A.
METEOROLOGICAL ROCKET NETWORK FIRINGS, VOLUME IV, NUMBER 1 Data Report
Jan. 1967 234 p

Wind and temperature measurements from all available meteorological sounding rocket firings for January 1967 are presented, along with computed values for pressure, density, and the speed of sound. Local radiosonde observations nearest the time of firing are also included. E.C.

N67-39343# Freie Univ., Berlin (West Germany). Inst. fuer Meteorologie und Geophysik.
METEOROLOGICAL DATA. VOLUME LXX, NO. 2: OBSERVATIONS MADE BY WEATHER SATELLITES AND THEIR EVALUATION. THE EUROPEAN WEATHER PICTURE, PART II, MAY–JUNE 1966 [METEOROLOGISCHE ABHANDLUNGEN. BAND LXX, HEFT 2: WETTERSATELLITENBEOBACHTUNGEN UND IHRE AUSWERTUNG DAS EUROPAEISCHE WETTERBILD 1966, TEIL II, MAI–JUNI 1966]
Ingrid Haupt et al 1967 215 p refs In GERMAN; ENGLISH summary
CFSTI: HC $3.00/MF $0.65

This volume 2 gives the weather-satellite observations of the European-Atlantic area for May and June, 1966. As in volume 1 it is made up of three parts. Part I gives a complete description of the premier equipment and the working methods of the Berlin APT-station. Besides this there are some remarks on the weather-satellite NIMBUS 2 and its different functions. In addition to the statements made in volume 1, there are some remarks on the snow and ice situation in the European-Atlantic area with exception of the Arctic. In continuation of volume 1 part II shows "Das Europäische Wetterbild" of all days in May and June 1966 with tables and special summaries. Part III presents in form of lists the most significant orbital data of ESSA 2 and NIMBUS 2 for the same period. Author

N67-39345# Finnish Meteorological Office, Helsinki.
CASE STUDIES ON ESTIMATION OF THE VERTICAL VELOCITY USING THE RATE OF PRECIPITATION
Martti Maekelae 1966 31 p refs
(Rept.-65)

The vertical velocity of air flow over Finland was calculated based on cyclonic rainfall rates on two dates in August 1963. Observations from two Finnish-based stations were used and verified on the basis of data collected by Tallin, Stockholm, and Leningrad meteorological stations. Results were checked using a kinetic method. It is concluded that calculating vertical velocity from rainfall rates over Finland would be a reliable method provided additional Finnish-based rainfall observation stations were available. Various meteorological data maps and vertical velocity tables are presented. E.C.

N67-39360 Finnish Meteorological Office, Helsinki.
PRECIPITATION AND SNOW COVER DATA, 1965, VOLUME 65, PART 2 [SADE JA LUMIHAVAINNOT, 1965, NIDE 65, OSA 2]
Sep. 1966 92 p In FINNISH and ENGLISH

Tabulated data and maps are presented of the precipitation during 1965 and snow recordings during the winter 1964–65 in Finland. The information is based on observations as reported by 120 stations in various parts of Finland. K.W.

N67-39368*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE REMOTE SENSING OF STRATOSPHERIC TEMPERATURES AND SOME RESULTS FROM THE NIMBUS II SATELLITE EXPERIMENT
Guenter Warnecke Sep. 1967 32 p refs Presented at Stanstead Seminars on the Middle Atmosphere 1967, Stanstead, Canada, 24 Jul.–5 Aug. 1967
(NASA-TM-X-55958; X-622-67-471) CSCL 04B

The Nimbus II medium resolution infrared radiometer measured atmospheric radiation in five spectral regions. Radiance measurements in a two-micron-wide spectral interval within the 15 micron carbon dioxide band permitted the derivation of vertically averaged stratospheric temperatures and made possible the daily monitoring of global stratospheric temperature patterns. The experiment lasted from May 15 through July 28, 1966. For this period, stratospheric temperature maps were produced by a computer program which included a method to eliminate the effect of dense high clouds on the 14 to 16 micron measurements. The method of measurement, the applied correction model, and some results of the Nimbus II experiment are described. Due to the seasonal restriction of the experiment, the derived global stratospheric temperature distributions exhibit the most interesting events over the Southern Hemisphere, where the southern polar winter vortex shows a pronounced asymmetry during the early winter of 1966. Within the 70 days of observation, this asymmetry travels around the South Pole and finally vanishes. The resultant horizontal cooling pattern seems to emphasize the important role of dynamic processes in the net cooling of the polar winter stratosphere. Author

21 NAVIGATION

Includes guidance; autopilots; star and planet tracking; inertial platforms; and air traffic control. For related information see also: 07 Communications.

N67-38113# Naval Oceanographic Office, Washington, D. C.
EVALUATION OF THE NAVY NAVIGATION SATELLITE SYSTEM AND THE OMEGA NAVIGATION SYSTEM
Willard M. Swartwood and Leslie L. Cunningham Aug. 1967 21 p
(IR-67-61; AD-657124)

The paper summarizes the results of tests conducted aboard the USS GYATT (DD-712), during the period 9 through 16 September 1966. The Navy Navigation Satellite System (NAVSAT) and the OMEGA Navigation System were evaluated using precise RADAR fixes from the Wallops Island RADAR Tracking Station as a yardstick. NAVSAT and OMEGA fixes gave position differences less than 0.5 nautical miles and 2 nautical miles, respectively. Author (TAB)

N67-38160# Parametrics, Inc., Waltham, Mass.
RADIOISOTOPE TAXI GUIDANCE SYSTEM. PHASE I: FEASIBILITY STUDY Final Report
B. Sellers, J. Hunerwadel and C. Ziegler Mar. 1967 74 p refs
(Contract FA-65-WA-1334)
(SRDS-RD-67-18; AD-655922)

Methods utilizing radioisotopes as an integral part of an all weather, zero visibility, ground guidance system have been evaluated. The most promising technique has been selected and examined in detail both theoretically and experimentally and a system design is presented. The method employs a stationary avionic gamma ray detector enclosed by a rotating collimator, which senses the position of the aircraft relative to a radioisotopic line source of radiation buried beneath the runway centerline. The avionic unit, approximately one cubic foot in volume, can be mounted in the interior of the aircraft and no structural modifications of the aircraft are required. The information displayed for the pilot is the position of the aircraft relative to the centerline, with an accuracy of better than plus or minus 5 feet at the centerline. The standard radarscope can be used as a display. A key feature of the system is that it uses a chemically inert radioactive gas, krypton-85, which is deployed in the pipe laid in the runway. When not in use the gas can be removed from the runway using conventional gas handling and pumping apparatus. Radiation safety aspects of an operational system have been examined and found to present no

hazard beyond normal industrial practice. An additional feature of the radioisotope system is that it can form the basis of an aircraft location and ground control system. The estimated total installation cost of the ground guidance system in a typical airport (Dulles) is about $41,000. The avionic units will cost between $2,300 and $3,300. Author (TAB)

N67-38196# Naval Air Development Center, Johnsville, Pa. Aero Mechanics Dept.
DETERMINATION AND APPLICATION OF INERTIAL COMPONENT WARM-UP CHARACTERISTICS Final Report
Kenton L. Bachman 3 Aug. 1967 37 p refs Presented at the 3d Inertial Guidance Test Symp., Sponsored by AF Missile Develop. Center, Holloman AFB, N. Mex.
(NADC-AM-6721; AD-657340)

Methods of determining warm-up characteristics of inertial components are investigated. A statistical definition in terms of noise and mean value is outlined. Major emphasis is given to the development of a thermal error model equation having broader system application. Examples illustrating the value of the modal for predicting errors in system alignment and gyrocompassing are shown. Author (TAB)

N67-38963# Federal Aviation Agency, Atlantic City, N. J. Test and Evaluation Div.
ATC CONCEPTS FOR SUPERSONIC VEHICLES, PART II-1 Interim Report
Andrew L. Sluka Aug. 1967 75 p refs
(RD-67-38)

A dynamic simulation study to determine what impact the supersonic transport (SST) will have on the air traffic control (ATC) system, as well as the ATC system impact on the SSTs operating characteristics is described. The simulation study investigated domestic and oceanic SST operations to and from John F. Kennedy International Airport in a simulated alpha numeric system representing a 1970 ATC environment. This study experimented with ATC aiding SSTs to place acceleration overpressure in sterile or sparsely populated areas, transitioning SSTs to and from parallel one-way track systems above FL 430 and the use of alpha numerics and flight path projection. Simulators were tied together to provide factual performance and handling characteristics of fixed-wing double delta aircraft. Results showed that alpha numerics and flight path projection will aid in controlling supersonic operations. More expeditious ATC handling for the SST is possible by the provision of parallel one-way routes whereas the assignment of the same routes to opposite direction SST traffic is undesirable. Author

22 NUCLEAR ENGINEERING

Includes nuclear reactors and nuclear heat sources used for propulsion and auxiliary power. For basic research see: 24 Physics, Atomic, Molecular, and Nuclear. For related information see also: 03 Auxiliary Systems; and 28 Propulsion Systems.

N67-38073# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Nuclear Labs.
FACTORS AFFECTING THE DESIGN OF RODDED UO_2 FUEL BUNDLES FOR HIGH POWER OUTPUTS
M. J. F. Notley and A. D. Lane Sep. 1967 24 p refs Presented at the Intern. Atomic Energy Agency Symp., Vienna, 11–15 Sep. 1967
(AECL-2945; SM-99/35) CFSTI: HC $3.00/MF $0.65

The economic advantage of increasing power density in nuclear fuels is accepted as being very substantial. The actual advantage depends upon such a number of factors that it should be assessed in the context of a specific reactor design. Regions where technical limitations to fuel operation are thought to exist, and outline some of the consequential relationships between parameters, that may affect any economic study are defined. Author

N67-38101# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Nuclear Labs.
ENGINEERING AND PERFORMANCE OF CANADA'S UO_2 FUEL ASSEMBLIES FOR HEAVY WATER POWER REACTORS
R. D. Page Sep. 1967 25 p refs Presented at the Intern. Atomic Energy Agency on Heavy Water Power Reactors, Vienna, 11–15 Sep. 1967
(AECL-2949) CFSTI: HC $3.00/MF $0.65

Significant improvements have been made in design of Zircaloy-2 UO_2 fuel for the Canadian power reactors. A replacement 82.5 mm diameter 19 element bundle for the Douglas Point reactor has been developed using a brazed split spacer design, instead of wire-wrap, thus preventing inter-element fretting of the sheath. Both wire-wrapped and brazed split spacer bundles have reached burnups in the range of 10,000–20,000 MWd/Te U at heat ratings with a maximum exposure of 1200 coolant days without failures in the NPD reactor. A 103.4 mm diameter 28 element bundle has been developed for the 500 MW(e) Pickering station. Deuterium pickup in operating Zircaloy-2 cladding, exposed to greater than 600 coolant days, has been low. For the Gentilly 250 MW(e) BLW, a fuel bundle has been developed to operate at 16% and greater exit steam qualities. Fuel bundles are being tested in the range 40 to 60 W/cm. A cold void volume has been designed into the elements by means of hollow end caps to avoid internal gas pressure exceeding coolant pressure. In-reactor heat transfer tests up to 45% exit quality have shown that the fuel will have a critical power ratio of 1.5. Fuel has been operated at 50% greater than critical power for three hours without significant deterioration of the sheath. Author

N67-38119# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
THE MONITORING OF RADIOACTIVE NOBLE GASES IN AIR
W. F. Merritt Jun. 1967 12 p refs
(AECL-2696) CFSTI: HC $3.00/MF $0.65

The radioactive noble gas content (Ar-41, Xe-133, Xe-135) of 400/ air samples collected in meteorological balloons was measured by γ-ray spectrometry. Particulates and volatiles were removed by a filter and a bed of activated charcoal in the sample line. The balloons were placed over a 7.6 cm × 7.6 cm NaI(Tl) crystal inside a large lead castle (76 cm × 76 cm × 76 cm) with 10 cm of shielding on all sides. The apparatus was calibrated with gas samples that had been assayed by absolute counting techniques. Ar-41 was compared with Co-60 in a high pressure 4π ionization chamber. Xe-133 and Xe-135 were separated from irradiated xenon in a mass separator and assayed by internal gas proportional counting. The counting efficiency of the crystal with varying volumes of gas in the balloons was measured and optimum conditions were selected. Efficiencies were Ar-41—0.11%, Xe-133—0.12%, Xe-135—0.46%. Measureable concentrations were Ar-41—3.5×10^{-9} μCi/cm^3, Xe-133 4.2×10^{-8} μCi/cm^3 and Xe-135 8×10^{-9} μCi/cm^3, i.e. two orders of magnitude below the MPC_a as set by the ICRP. Author

N67-38276# Battelle Memorial Inst., Columbus, Ohio.
DESIGN OF A CAPSULE FOR IRRADIATION NEAR 2000°C
William J. Zielenbach and Joseph W. Ray 6 Jul. 1967 24 p
(Contract W-7405-ENG-92)
(BMI-1808) CFSTI: HC $3.00/MF $0.65

A capsule was designed for irradiating samples at 1800 to 2000°C at a heat rate of 2.8 kw per ft. A useful range of temperature control was obtained using a binary gas mixture of variable composition in the outer capsule annulus. Heat-transfer studies of various configurations were conducted to determine the best scheme for temperature measurement. In the concept chosen, a sheathed thermocouple was located in a thick section of cladding which was removed from the point of maximum temperature by about 180°C. Two experiments were conducted with additional bare, stranded thermoelements attached to the exterior of the cladding at the point of maximum temperature to verify the predictions. Measured thermal gradients correlated with the predicted values but the overall performance of the sheathed thermocouples was poor. Temperatures of 1700 to 1800°C were obtained. Author (NSA)

N67-38284 Florida Univ., Gainesville.
REACTOR CALCULATIONS
G. R. Dalton and D. D. Orvis *In its* Study of Nucl. Seeded MHD Plasmas 1 Jun. 1967 p 150–176 ref (See N67-38280 23-25)

A preliminary design study was made on a nuclear reactor for use in ionizing or seeding and heating the gas in a magnetohydrodynamic system to establish the relationship between various reactor parameters. A series of steady state engineering models were used with selected data which were internally consistent throughout. Conclusions were drawn to evaluate the suitability of the parameters initially selected. The discussion covers the core geometry and materials, criticality calculation, effect of coolant loss on stability, neutron flux levels and spectra, ion production in He^3, consumption and inventory of He^3, and heat transfer. R.N.A.

N67-38312# General Electric Co., Cincinnati, Ohio. Nuclear Technology Dept.
AEC FUELS AND MATERIALS DEVELOPMENT PROGRAM Progress Report, 31 Jan.–30 Apr. 1967
30 Jun. 1967 178 p refs
(Contract AT(40-1)-2847)
(GEMP-67) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: high-temperature reactor materials; radiation effects on fast reactor cladding and structural materials; refractory metal alloys; physical metallurgy of refractory metal alloys; physico-chemical properties of Fe–Cr–Al-clad fuel elements; advanced long-life reactor fuel cladding and structural materials; radiation effects on heat-resistant metals and alloys; plastic fatigue properties of heat-resistant alloys; advanced pressure vessel materials; physico-chemical properties of clad UO_2 in potential meltdown environments; high-temperature thermocouple and electrical materials; high-temperature carbides for fuel and structural applications. NSA

N67-38329 Atomic Energy Establishment, Winfrith (England). Technical Assessments and Services Div.
THE VALIDITY OF METHUSELAH II IN WATER MODERATED LATTICE CALCULATIONS
D. Hicks and D. R. Hopkins Jan. 1967 36 p refs
(AEEW-R-397) HMSO: 5s

An improved version of the METHUSELAH code has been developed that embodies some refinements in the treatment of the thermal spectrum, improved cross-section data, and a neutron balance output. The changes in nuclear data and physical models are summarized. The METHUSELAH II predictions are compared with published lattice reactivity and reaction rate data. The systems examined include British S.G.H.W. type lattices (with H_2O and D_2O moderation), Canadian natural uranium/D_2O experiments, U.S. low enrichment H_2O systems, and the Hanford Pu Al/H_2O experiments. In general the agreement is sufficiently good to demonstrate the value of METHUSELAH II as an assessment tool and to indicate clear improvements over METHUSELAH I. A number of discrepancies are observed. Author

N67-38330 Atomic Energy Establishment, Winfrith (England). Technical Assessments and Services Div.
AN ANALYSIS OF WATER REACTOR BURNUP DATA WITH THE METHUSELAH II CODE
M. Floyd and D. Hicks Jan. 1967 23 p refs
(AEEW-R-399) HMSO: 3s

The METHUSELAH II code has been used to predict long term reactivity and isotopic changes in the YANKEE, Dresden and NRX reactors. In general it is shown that there is a satisfactory measure of agreement and the first core lives of YANKEE and Dresden appear well predicted. However, there are discrepancies in the isotopic composition of the plutonium formed which appear to be correlated with the degree of hardness of the reactor spectrum. It is demonstrated that plausible changes in nuclear data could reduce the discrepancies. Author

N67-38334*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
A MONTE CARLO PROGRAM FOR CALCULATION OF DOPPLER COEFFICIENTS
Robert E. Sullivan Washington, NASA, Oct. 1967 45 p
(NASA-TN-D-4200) CFSTI: $3.00 CSCL 18F

A Monte Carlo program for the calculation of Doppler coefficients in arbitrary neutron flux spectra is presented. The program is designed to determine the effective cross sections of resonance scatterers and absorbers with a cylindrical or infinite slab geometry. The code may also be used to study the effect of resonance overlap in mixtures of isotopes and to investigate the approximations used in analytical calculations of the effective resonance integrals. As a test of the accuracy of the program, a flat in lethargy spectrum is used to obtain Doppler coefficients for several gold 197 samples, and the results are compared with values obtained by using the Nordheim calculation, which is expected to be nearly exact for such cases. These calculations are compared with published experimental values of Doppler coefficients for gold 197. While a large discrepancy is observed between the Monte Carlo and experimental results, the Monte Carlo values agree well with the results of the Nordheim calculation. Author

N67-38339 Atomic Energy Establishment, Winfrith (England). Development Div.
QUAVER: A PROGRAMME TO EVALUATE MONOPOLE AND DIPOLE BOUNDARY CONDITIONS IN PRESSURE TUBE REACTOR LATTICES
F. R. Allen Apr. 1967 52 p refs
(AEEW-R-515) HMSO: 7s

In order to apply source-sink theory to pressure tube reactor lattices it is necessary to calculate boundary conditions at the fuel channel/moderator interfaces to be satisfied by the neutron flux. A method is described for evaluating the necessary coefficients using multi-group diffusion theory in a cylindricalised lattice cell for both monopole and dipole components of flux. Provision is made for in or out leakage of neutrons in each group at the cell boundary so that allowance can be made for effects of cell environment on the channel boundary conditions. The programme QUAVER (written in EGTRAN) is described for use on the English Electric KDF9 computer. QUAVER outputs the boundary condition matrices on cards for use in source-sink core calculations, and includes a facility for the condensation of the primary group output to a secondary group structure. The numerical method and the data input specification are described together with full details of a sample calculation. Author

N67-38340# Japan Atomic Energy Research Inst., Tokyo.
RICM—AN IBM-7090 CODE OF RESONANCE INTEGRAL CALCULATION FOR MULTI-REGION LATTICE
Aug. 1967 47 p
(JAERI-1134)

The resonance absorption integral of a resonant isotope in an multi-region (≤5 regions) lattice is calculated by an IBM-7090 code, RICM. The lattice configurations to be considered here are a slab lattice, an actual square or hexagonal lattice, and an approximated cylindricalized lattice with the isotropic or perfect reflecting boundary condition. Cases of an isolated rod or plate and a homogeneous system can be also calculated. Slowing down of neutrons by each isotope in each region is treated either by exact numerical integration of the slowing down equation, narrow- or wide-resonance approximation. The RICM code consists of three programs, i.e. MAIN, LTE and FFCP-S, RN, or C. LTE calculates values of the doppler functions for resolved and unresolved level regions and prepares a library tape for the MAIN. FFCP-C, RN and S calculate collision probabilities in the cylindrical and slab lattices, respectively, and produce an input card deck for the MAIN. Using the library tape and the probability card deck, the MAIN calculates the resonance absorption integral of the resonant isotope in each region, energy spectrum and others. Author

N67-38341# Atomics International, Canoga Park, Calif.
SNAP REACTOR ABLATION–DISINTEGRATION EXPERIMENT (RADE) IN A HYPERTHERMAL WIND TUNNEL
J. E. Arnold and L. D. Montgomery 30 Jun. 1967 132 p refs
(Contract AT(04-3)-701)
(NAA-SR-12382) CFSTI: HC $3.00/MF $0.65

Experimental support for current SNAP reactor reentry burnup analytical programs was provided by a series of ablation tests on half-scale reactor models exposed to a partially simulated reentry environment. Measurements of the aerodynamic heat flux to the complicated geometry of SNAP reactors were obtained with gold-plated calorimeter models. Data were also obtained on the transient temperature response of the reactor models and on the mode of disintegration of the forward components of the reactors. Application of the measured heat flux data to the analytical method resulted in good correlation of the analytical calculations with the experimental temperature response of the models. These tests failed to demonstrate the mode of fuel element release from the vessel since ablation of the reactor models terminated long before the fuel element bundle was exposed to any great extent. Even though this objective was not satisfied, the results have rendered valuable information to the SNAP reactor reentry burnup program.
Author (NSA)

N67-38342# Atomics International, Canoga Park, Calif.
ANALYSIS OF SNAPTRAN-1 AND -2 REACTOR KINETICS EXPERIMENTS
J. F. Jackson, W. F. Rhoades, and L. I. Moss 26 Jun. 1967 184 p refs
(Contract AT(04-3)-701)
(NAA-SR-11850) CFSTI: HC $3.00/MF $0.65

Extensive analyses of the SNAP Transient (SNAPTRAN)-1 nondestructive test series were performed to extract basic kinetics data for a wide range of transient conditions. Detailed analyses of the SNAPTRAN-2 test were also performed to assess the behavior of the SNAP 10A/2-type reactor during a destructive transient. Assessment of the kinetics data was also of principal interest as was the mode of reactor shutdown. A detailed correlation between experiments and analyses was made. Author (NSA)

N67-38343# Atomics International, Canoga Park, Calif.
EXPERIMENTAL INVESTIGATION OF THE THERMOCHEMICAL BEHAVIOR OF SNAP FUEL MATERIAL IN A HYPERTHERMAL WIND TUNNEL
J. E. Arnold and A. W. Barsell 20 Jun. 1967 159 p refs
(Contract AT(04-3)-701)
(NAA-SR-12082) CFSTI: HC $3.00/MF $0.65

Experimental support for SNAP fuel element reentry burnup analytical programs and associated fuel particle disintegration studies was provided by a series of ablation tests on actual fuel material in a partially simulated reentry environment. Data were obtained on the transient temperature and hydrogen effusion behavior, surface catalycity effects on heat flux, and ablating particle size distributions and compositions. It was found that good temperature correlation was possible for those test conditions in which nonequilibrium flow effects were small. Fuel surface catalycity effects were found to cause significant heating reductions at conditions where departure from equilibrium flow was effected. For ablating particle size determinations, a laser photographic system proved to be a highly valuable tool. Author (NSA)

N67-38361 Atomic Energy Establishment, Winfrith (England). Fast Reactor Physics Div.
MEASUREMENTS AND CALCULATIONS OF RATIOS OF EFFECTIVE FISSION CROSS-SECTIONS IN THE ZERO-POWER FAST REACTOR, ZEBRA
J. M. Stevenson and A. M. Broomfield Jun. 1967 26 p refs
(AEEW-R-528) HMSO: 4s

The comparison of measured and calculated central fission ratios provides a useful method for checking the accuracy of calculated spectra and fission cross-section data. A set of parallel plate fission chambers was specially made for Zebra. The wall thickness was reduced to reduce the degradation of the spectrum. The fissile coatings in the earlier chambers were prepared by a painting technique and those in the later chambers by an electrodeposition method. The mass deposited was determined by low geometry α-assay. The construction of the chambers and the method of calibration and use are described. Central fission ratios in six Zebra cores measured to an accuracy of 1–3% are compared with values computed using the FD2 data set and the CRAM or SCRAMBLE multigroup diffusion theory programmes. This comparison suggests that the calculations give too few neutrons at high energies. There is also evidence that some of the fission cross-section data used in the FD2 set is in error. Author

N67-38377# Atomic Energy of Canada, Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.
HEAT-TREATED Zr-2.5 % Nb PRESSURE TUBES FOR WATER-COOLED POWER REACTORS
W. Evans, J. E. LeSurf, and W. R. Thomas May 1967 18 p refs Presented at the Intern. Conf. on World Rev. of Nucl. Reactors and Radioisotopes, Montreal, May 1967
(AECL-2890; CONF-670522-2) CFSTI: HC $3.00/MF $0.65

Results are presented of a research program to develop Zr–Nb alloy pressure tubes for water-cooled power reactors. The alloy tubes produced have acceptable corrosion resistance, higher strength, and when heat-treated will oxidize no more than Zircaloy-2 under reactor conditions; in addition H pickup per unit area will be less. NSA

N67-38450 Atomic Energy Establishment, Winfrith (England). Water Reactor Physics Div.
A METHOD OF INFERRING K-INFINITY FROM REACTION RATE MEASUREMENTS IN THERMAL REACTOR SYSTEMS
D. A. Newmarch May 1967 34 p ref
(AEEW-R-512) HMSO: 4s 6d

A scheme is described for inferring a value of k-infinity from reaction rate measurements. The method is devised with the METHUSELAH group structure in mind and was developed for the analysis of S.G.H.W. reactor experiments; the underlying principles, however, are general. Author

N67-38451 Atomic Energy Establishment, Winfrith (England). Development Div.
HAMBO: A COMPUTER PROGRAMME FOR THE SUBCHANNEL ANALYSIS OF THE HYDRAULIC AND BURNOUT CHARACTERISTICS OF ROD-CLUSTERS. PART I: GENERAL DESCRIPTION
R. W. Bowring Apr. 1967 29 p refs
(AEEW-R-524) HMSO: 4s

HAMBO is a computer code for the steady-state hydraulic analysis of a rod-cluster assembly cooled by a boiling fluid, using a subchannel model. The cluster burnout power is assessed by means of a subchannel burnout correlation. Clusters which can be represented with 10 subchannels, i.e. with up to 37 rods in a cylindrical pressure tube, can be analysed with the present version of the programme. The code is primarily a design tool for the thermal performance assessment of fuel assemblies in nuclear reactors cooled by water–steam mixtures. It can be used to assess the effect of change in cluster radial flux depression, rod pitch, bowing and eccentricity on the fluid density and burnout power. Author

N67-38536*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
ESTIMATES OF DOPPLER COEFFICIENTS FOR IN-PILE THERMIONIC REACTOR MATERIALS
Richard L. Brehm 1 Oct. 1967 23 p refs
(Contract NAS7-100)
(NASA-CR-85358; JPL-TR-32-1077) CFSTI: HC $3.00/MF $0.65
CSCL 18J

Recent experimental data have been used to estimate temperature coefficients of reactivity due to doppler broadening of resonances in materials of interest for compact in-pile thermionic-reactor-core concepts. Materials considered are U-235, U-238, and the refractory metals, tungsten, tantalum, molybdenum, and niobium. Equations giving the magnitude and temperature dependence of the doppler coefficient are given for each of these elements. Estimates are given of the possible error in the doppler coefficient introduced by extrapolating the experimental data to the higher temperatures of interest in thermionic reactor concepts. A comparison of this method with the usual theoretical method is made for the Fermi reactor. Author

N67-38548# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
A METHOD FOR STUDYING THE EFFECTS OF PROPAGATION OF THE FINE NEUTRON STRUCTURE IN FAST REACTORS DUE TO THE LIGHT SCATTERING ELEMENTS
A. Gandini and M. Salvatores 1967 11 p refs
(RT/FI-(67)11)

A method for making fine structure measurements for analysis of fast reactor experiments is presented. The method is applied to ZPR-9 and ZPR-6 assemblies. Numerical results are presented. Reactivity worths are calculated as a function of change in macroscopic cross section and are presented in tabular form. 10 references. NSA

N67-38587# Oak Ridge National Lab., Tenn.
MODEL FOR COMPUTING THE MIGRATION OF VERY SHORT-LIVED NOBLE GASES INTO MSRE GRAPHITE
R. J. Kedl Jul. 1967 26 p refs
(Contract W-7405-ENG-26)
(ORNL-TM-1810) CFSTI: HC $3.00/MF $0.65

A model describing the migration of very short-lived noble gases from the fuel salt to the graphite in the MSRE core was developed. From the migration rate, the model computes (with certain limitations) the daughter-product distribution in graphite as a function of reactor operational history. Noble gas daughter-product concentrations (^{140}Ba, ^{141}Ce, ^{89}Sr, and ^{91}Y) were measured in graphite samples removed from the MSRE core after 7800 Mwhr of power operation. Concentrations of these isotopes computed by this model compared favorably with the measured values. Author (NSA)

N67-38608# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.
RADIOLOGICAL ASPECTS OF THE SNAPTRAN-2 DESTRUCTIVE TEST
O. L. Cordes, D. F. Bunch (AEC), J. R. Fielding, and J. K. Warkentin Feb. 1967 51 p refs
(Contract AT(10-1)-205)
(IDO-17203) CFSTI: HC $3.00/MF $0.65

Radiological information obtained from monitoring a planned destructive excursion of a modified SNAP 10A/2 reactor is described along with the sampling and analytical techniques used to obtain the information. An analysis of the data is included which indicates that only 21 percent of the fission products was released, that the radiation hazards were low, and that the beryllium from the reactor drums and reflectors did not produce a health hazard. Author (NSA)

N67-38610# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
IRRADIATION EFFECTS ON REACTOR STRUCTURAL MATERIALS Quarterly Progress Report, Aug.–Oct. 1966
15 Nov. 1966 173 p refs
(Contract AT(45-1)-1830)
(BNWL-CC-883) CFSTI: HC $3.00/MF $0.65

Developments are reported for studies on: tube burst tests on irradiated EBR-II fuel jackets; radiation effects on mechanical properties of type 347 stainless steel; neutron radiation effects on iron; effects of substructure on irradiation stability of ASTM A302 Grade B steel; fracture toughness of reactor pressure vessel steels; radiation effects on notch ductility of steels; radiation effects on refractory metals and heat resistant alloys; effects of helium on mechanical properties of type 304 stainless steel; radiation effects on reactor metals; ATR gas loops; and in-reactor fatigue testing of reactor structural steels. NSA

N67-38629# Oak Ridge National Lab., Tenn. Reactor Div.
TERRESTRIAL LOW-POWER REACTOR PROGRAM Quarterly Progress Report, Period Ending 31 Mar. 1967
Jul. 1967 38 p refs
(Contract W-7405-ENG-26)
(ORNL-4136) CFSTI: HC $3.00/MF $0.65

A survey was conducted to collect information on the size, weight, and cost of several primary power sources. Data are given for diesel generators, batteries, fuel cells, and radioisotope energy sources. Several design precepts are discussed. Reactor design studies of both a 1500-kW(e) boiling-water reactor direct-cycle power plant and a 1500-kW(e) pressurized-water reactor power plant are in progress. Both systems are for land-based applications with heat rejected to air. The designs are being restricted to meet the requirements of air-transportable packages. The factors leading to the choice of small high-speed turbine-generator units with water-lubricated bearings are discussed. Geometric and performance data are tabulated for 30-, 150-, 500-, and 1500-kW(e) units. A general mathematical approach to the problem of reactor and system control is described. An investigation of the critical sizes, power distributions, and void coefficients of calandria-type boiling-water reactors was begun. The preliminary design of an environmental test facility for low-power isotope power plants is being prepared. The facility will test units designed for both land surface and deep ocean applications. Author (NSA)

N67-38852# Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.
PRELIMINARY CALCULATIONS FOR H_2O-MODERATED LATTICES OF UO_2-4 WT. PERCENT PuO_2 FUEL RODS
S. Kobayashi and V. O. Uotinen 17 May 1967 32 p refs
(Contract AT(45-1)-1830)
(BNWL-CC-1205) CFSTI: HC $3.00/MF $0.65

Physics calculations, preliminary to experiments, for determining cell-averaged lattice constants are presented. Calculations were made for 7.85 wt % and 23.5 wt % ^{240}Pu lattices for three geometries. All parameters are tabulated. Cell-averaged macroscopic cross sections are shown as a function of lattice spacing. Numerical descriptions are given for each of the ^{240}Pu cores. The calculated thermal neutron energy spectrum is shown. NSA

N67-38797# Institutt for Atomenergi, Kjeller (Norway).
THE SECOND NPY INTERNATIONAL ADVANCED SUMMER SCHOOL ON REACTOR PHYSICS. INTERPRETATION, ANALYSIS, AND UTILIZATION OF REACTOR PHYSICS EXPERIMENTS IN THERMAL NEUTRON CRITICAL AND SUBCRITICAL ASSEMBLIES, SANDEFJORD, NORWAY, 22ND AUGUST–2ND SEPTEMBER 1966
1966 391 p refs
(KR-117)

The concept of material buckling in reactor theory starting from elementary monoenergetic diffusion theory is discussed. This is done by considering the nature of the solutions of the time-independent neutron balance equation for an infinite, homogeneous, isotropic, multiplying medium. The generalization to heterogeneous or non-isotropic media is also discussed. It is found that the solution to the general equation, which admits both positive and negative flux densities, is equivalent to the solution of a certain eigenvalue equation. The principal eigenvalue of this equation is the buckling, and the associated eigenfunction leads to the most persistent form of the neutron flux. The concept of geometrical buckling is introduced by considering the eigenvalues of the equation $\nabla^2 f + \mu^2 f = 0$, assumed to hold in a given closed spacial region and to vanish on the boundary. The geometrical buckling is the principal eigenvalue of this problem, and the associated eigenfunction is the only solution with no nodal surface in the region. In the diffusion approximation, the time-independent flux in a bare reactor must be the principal eigenfunction of both equations and the two principal eigenfunctions must be identical. The implications for the time-dependent equation and for the theoretical problem of the search for k_{eff} are considered. The material buckling as a useful characterization of the measurement of reproducing properties of a medium is discussed. The standard single region and reflected exponential experiments are discussed. The difficulty in practice posed by the presence of special transients is reviewed, and the inherent error in buckling and k_{eff} are estimated in specific cases. The use of the measured data in the theory is described. Author (NSA)

N67-38828# Atomic Energy Commission, Washington, D. C. Isotopes Development Div.
ISOTOPE SYSTEMS DEVELOPMENT PROGRAM
Dec. 1966 89 p refs Presented at the 8th Ann. Contractors Meeting, 5–7 Dec. 1966
(CONF-661203) CFSTI: HC $3.00/MF $0.65

A review of progress in the development of new principles and techniques for using isotopes is presented. Papers presented at the conference are categorized as basic information, analytical aspects, marine device development, environmental applications, industrial applications, aerospace applications, and national security applications. NSA

N67-38844# Atomic Energy of Canada, Ltd., Pinawa (Manitoba).
THE BEHAVIOUR OF ZIRCALOY-2 AND Zr-2.5 PERCENT Nb CLAD URANIUM DIOXIDE FUEL IN AN ORGANIC COOLANT. THE X-719 IRRADIATION
J. F. Walker Nov. 1966 26 p refs
(AECL-2661; EXP-NRX-71907) Available from Atomic Energy of Canada, Ltd., Chalk River: $1.00

Three Zircaloy-2-clad and three Zr–2.5% Nb-clad elements were successfully irradiated in the X-7 loop, at WR-1 temperatures and ratings. Some of the elements were at power for 117 days and reached a burnup of 3500 MWd/Te U. H_2 absorption by the cladding alloys was studied in detail by analysis and metallography. The absorption rate for Zr–2.5% Nb was 0.04 $\mu g\ cm^{-2}\ h^{-1}$, which was about half that of Zircaloy-2. H_2 picked up by the cladding had diffused to the cooler wire wrap, which was severely embrittled on the Zircaloy-2 elements. Surface fouling was negligible. Surface oxidation and fission gas released from the fuel were both small. The results indicate that the WR-1 Zr–Nb-clad production elements will perform satisfactorily to their designed burnup. Author (NSA)

N67-38845# Kiel Univ. (West Germany).
SPECTRA OF NEUTRON CAPTURE GAMMA RADIATION OF GASES [SPEKTREN VON NEUTRON ENEINFANGGAM-MASTRAHLUNG AN GASEN IM TANGENTIALSTRAHLROHR EINES REAKTORS]
P. Wille and D. Bellmann Mar. 1967 17 p refs In GERMAN
(BMwF-FBK-67-25)

Spectrometry of gamma radiation following neutron capture of internal targets in a reactor was performed by NaI (Tl) scintillation detectors. A 5 in.×4 in. NaI (Tl) detector in total absorption and a three-crystal pair spectrometer were used. The targets were nitrogen, neon, and argon. The measurements were performed to test if lithium-drifted germanium detectors could be used in this configuration concerning background and intensity of the spectra. The uncorrected spectra measured with the pair spectrometer are given. The measurement on nitrogen (5 in.×4 in. NaI) was done to get the average neutron flux in the port. Author (NSA)

N67-38880# Harvard Air Cleaning Lab., Cambridge, Mass.
PROCEEDINGS OF THE NINTH AEC AIR CLEANING CONFERENCE, VOLUME 1
James M. Morgan, Jr., ed. and Melvin W. First, ed. Jan. 1967 573 p refs Conf. held in Boston, 13–16 Sep. 1966; Sponsored by AEC
(CONF-660904, Vol. 1)

Presented are articles on the use and effectiveness of high efficiency air cleaning systems and filters for reactor control and accident prevention, contaminant removal, fission product confinement and containment, nuclear waste incineration, sodium and plutonium aerosols, and exhaust system monitoring and safety assurance. For individual titles see: N67-38881–N67-38903

N67-38881# Battelle Memorial Inst., Columbus, Ohio.
ANALYTICAL DESCRIPTION OF THE DISTRIBUTION OF FISSION PRODUCTS DURING NUCLEAR REACTOR ACCIDENTS FOR WATER AND GAS COOLED REACTORS
David L. Morrison, James A. Gieseke, and Robert L. Ritzman *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 4–27 refs (See N67-38880 23-22)
(Contract W-7405-ENG-92)

A mathematical model has been developed to describe fission product release during water-reactor accidents. The input parameters for the equations for the release from the fuel are based upon experimental data, and the temperature input to the model is supplied from an independent heat transfer analysis. The transport and deposition of the fission products in the core and

primary vessel are calculated to provide the source term for the transport and deposition analysis within the containment vessel. Two simple models, transport within a well-mixed gas or diffusion in a stagnant gas, are considered for this region. An analytical description of the time–space distribution of fission products in an accident can be obtained by the proper combination of these mathematical models. A list of 28 references is included. Author (NSA)

N67-38882# Atomics International, Canoga Park, Calif.
CHARACTERIZATION OF SOURCE TERMS FOR AEROSOL TRANSPORT DURING SODIUM FIRES
G. N. Lauben and C. L. Larson *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 28–51 refs (See N67-38880 23-22)
(Contract AT(11-1)-GEN-8)

The sources, consequences and radiological considerations resulting from a postulated spill in a reactor system are studied as they relate to aerosol transport. The heat and mass transfer processes and system variables are discussed. Analytical approaches are discussed with an example involving a semi-empirical accident model which includes gas buoyancy considerations. The current experimental systems and recent early results are described. Author (NSA)

N67-38883# Commissariat a l'Energie Atomique, Cadarcache (France). Service d'Etudes de Surete Radiologique.
IN PILE STUDIES OF CONTAMINATION RELEASED IN CO_2 GAS COOLED REACTORS
J. Dadillon *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. I Jan. 1967 p 52–61 (See N67-38880 23-22)

Experiments have been made using an in-pile loop in which UO_2 fuel elements with clad failure were irradiated. We were essentially interested in the I and its compounds. The filter packs used for sampling were composed of an asbestos paper, a knit-mesh (silver-plated copper wool), a charcoal-impregnated paper, five 1 cm thick charcoal beds and a final 5 cm charcoal bed maintained at temperature of −40°C. There were at least two iodine compounds in the loop with different behavior in charcoal; the efficiency of 5 cm charcoal for the compounds or the forms which have not been trapped by the impregnated paper or the knit-mesh was about 99%; the charcoal impregnated paper trapped from 3 to 13% of the total activity; only about 1% of iodine generally remained in the knit-mesh. Author (NSA)

N67-38884# Oak Ridge National Lab., Tenn.
REQUIREMENTS FOR FIRE-RESISTANT HIGH-EFFICIENCY PARTICULATE AIR FILTERS
C. A. Burchsted *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 62–78 refs (See N67-38880 23-22)

The establishment of certain basic specification requirements is essential to the procurement of suitable high-efficiency particulate air filters with a minimum of difficulty and cost. Problems have been experienced in the manufacture and procurement of these filters because of inconsistent, ambiguous, and conflicting specification requirements as well as requirements that are not restrictive enough. The requirements for high-efficiency particulate air filters presented in this paper are intended to guide the specification writer toward standards that will produce uniformity in construction and testing practices to bring the cost of these units down to reasonable levels without sacrificing the necessary performance. Author

N67-38888# Oak Ridge National Lab., Tenn.
DEVELOPMENTS IN CONTAMINATED FILTER REMOVAL EQUIPMENT
C. A. Hahs *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 149–158 (See N67-38880 23-22)

Equipment used to filter gases exhausted from a nuclear facility and the methods by which this equipment will be removed and replaced require careful planning. One filter removal carrier has been designed to remove filters from both the older and the newer filter pit installations and to provide γ and/or neutron shielding during this operation. Other developments in removal technique are exemplified by the methods used to remotely remove, transport, and deposit in-cell canister filters in disposable casks, and by the methods used to seal glove-box exhaust filters in their own polyethylene tubes before removing them. Author (NSA)

N67-38889# United Kingdom Atomic Energy Authority, Windscale (England). Reactor Development Lab.
THE DEVELOPMENT OF IMPREGNATED CHARCOALS FOR TRAPPING METHYL IODIDE AT HIGH HUMIDITY
D. A. Collins, L. R. Taylor, and R. Taylor *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 159–198 refs (See N67-38880 23-22)

Methyl iodide can be present in releases of iodine from irradiated fuel and a high humidity most activated charcoals will not provide efficient permanent retention of methyl iodide. Impregnation of activated charcoal with certain amines or inorganic halides has been found to improve the retention of methyl iodide at high humidity. The best results are given by triethylenediamine or potassium iodide supported on 207B charcoal. The behavior of these two impregnated charcoals has been examined in more detail. Design data are presented in the form of a linear relationship between log DF and stay-time in the charcoal bed, and a predicted allowance for ageing of charcoals exposed to a continuous flow of air. The performance during and after exposure to steam at high temperature has been measured. Author

N67-38890# Oak Ridge National Lab., Tenn. Reactor Chemistry Div.
RETENTION OF METHYL IODIDE BY IMPREGNATED CARBONS UNDER AMBIENT CONDITIONS
G. W. Parker, G. E. Creek, and A. Ferrell *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 199–229 refs (See N67-38880 23-22)

The effects of impregnating charcoal are discussed with reference to efficiency of methyl iodide removal from reactor containment systems. Performance tests on charcoals in the HFIR and LOFT are discussed. The effects of humidity on the filter efficiency are illustrated. NSA

N67-38891# California Univ., Livermore. Lawrence Radiation Lab.
MECHANISMS THAT AFFECT THE ADSORPTION OF METHYL IODIDE ON CHARCOAL UNDER HUMID CONDITIONS
Frank J. Ackerman and John Z. Grens *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 230–249 refs (See N67-38880 23-22)

Breakthrough curves of the adsorption of methyl iodide from air on charcoal were experimentally measured over the range of 20–100% humidity. The observed breakthrough curves can be explained by assuming two rate controlling mechanisms for mass transfer; bulk diffusion was found to control the adsorption rate during the early period, while pore diffusion was found to control later in the adsorption process. Water vapor greatly limits the

external surface adsorption capacity of the charcoal for methyl iodide. Water vapor also hinders the rate of mass transfer by pore diffusion. Author

N67-38895# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.

PERFORMANCE OF AIRBORNE ACTIVITY CONFINEMENT SYSTEMS IN SAVANNAH RIVER PLANT REACTOR BUILDINGS

W. S. Durant *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 348–370 refs (See N67-38880 23-22)

(Contract AT(07-2)-1)

A filtration-adsorption system is installed in the ventilation exhaust of each reactor building at the Savannah River Plant for confinement of airborne particulate and iodine vapor activity that might be released in the highly unlikely event of a reactor accident. Air from the process areas of each building is passed continuously through moisture separators, then through particulate filters, and finally through iodine adsorber beds of activated carbon. The system has the demonstrated ability to confine over 99% of airborne particulate activity and over 99.9% of all forms of airborne halogen activity that could form under emergency conditions that might exist following an accident in the SRP reactors. A continuing program of development, testing, and maintenance ensures that these high efficiencies will be maintained during operation. Experience has been satisfactory for over 3 years of operation. Author

N67-38896# Harvard Air Cleaning Lab., Cambridge, Mass.

FLOATING ROOF CONTAINMENT VESSELS

Melvin W. First, Leslie Silverman, Daniel Pender, and Stanley Dawson *In its* Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 371–388 ref (See N67-38880 23-22)

Theoretical and experimental evaluations show that complete containment of the products of a nuclear reactor accident can be accomplished using a modified commerical gas holder. A holder capable of storing in excess of 20×10^6 cubic feet could retain such releases at a pressure substantially the same as ambient. As a first step in the evaluation of this concept, a small pre-pilot model was constructed to obtain information on seal mechanisms, lubricants, and functional parameters. Based on the resulting data, a 500 cubic foot floating type pilot-scale gas holder has been designed and is currently under construction. Advantages of the proposed system include its relatively low cost and the fact that the radioactive materials retained in the holder can later be removed by one or a combination of several decontamination methods. Author (NSA)

N67-38897# Douglas United Nuclear, Inc., Richland, Wash.

CONFINEMENT SYSTEMS TESTS PERFORMED DURING DEACTIVATION OF THE 100-F REACTOR

M. L. Smith *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 389–418 refs (See N67-38880 23-22)

Permanent shutdown of 100-F plutonium production reactor at Hanford made the system for confining the particulate and halogen, in the exhaust air, available for testing. The following tests were performed and the results are shown throughout the text: Iodine deposition from the airstream, iodine removed from airstream by fog spray, Encapsulation of the reactor exhaust air in foam, Effectiveness of fog spray for removing noble gases from the air, Effectiveness of the filter system for removing iodine from the exhaust air. Author

N67-38898# United Kingdom Atomic Energy Authority, Windscale (England). Reactor Development Lab.

AIR CLEANING FOR REACTORS WITH VENTED CONTAINMENT

R. D. Collins, J. J. Hillary, and J. C. Taylor *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 419–453 refs (See N67-38880 23-22)

A program of experimental work has been carried out under conditions appropriate to possible depressurization-type accidents to the Steam Generating Heavy Water Reactor (SGHW) at Winfrith Heath which has vented containment. The work has included small-scale experiments in glass or silica apparatus in which measurements have been made of the extent and form of the I_2 release from Zr-clad UO_2 into steam under melting conditions and at about 1000°C. A number of tests have been conducted with simulated forms of I_2 on two large-scale steel models of the reactor water lute steam suppression system. Tests have also been carried out on 1000 cfm filter units to develop droplet disentrainment devices. Work on the development of charcoals to deal with penetrating I (methyl iodide) under wet conditions is reported separately. Author (NSA)

N67-38899# Oak Ridge National Lab., Tenn. Reactor Chemistry Div.

EFFECTS OF CONTAINMENT SYSTEM SIZE ON FISSION PRODUCT BEHAVIOR

G. M. Watson, R. B. Perez, and M. H. Fontana *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 454–495 refs (See N67-38880 23-22)

Simple mathematical models to aid in the determination of effect of containment size on plate-out behavior of iodine have been postulated. In the absence of steam the principal assumptions made were: (1) homogeneous mixing; (2) boundary gas layer enveloping all surfaces; (3) diffusion through boundary layer to be the rate limiting process; (4) molecular iodine present, methyl iodide absent. Mathematical relations in terms of mass transfer coefficients, and surface-to-volume ratios of containers and surface characterization parameters were developed for cases with and without desorption from partially covered surfaces. In the presence of condensing steam, it has been assumed that the iodine flux which consists of diffusive and bulk flow components may be approximated by the bulk flow component alone, neglecting the diffusive component. Author

N67-38900# California Univ., Livermore. Lawrence Radiation Lab.

VENT GAS TREATMENT PLANT

J. Ackerman, R. Bundrick, J. Cowles, V. Du Val, J. Grens et al *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 496–508 refs (See N67-38880 23-22)

A design of a vent gas treatment plant for Project Dribble is presented. The methods of removal of radioactive particulates and the control of gas release rate are discussed. The portability of the plant to prevent seismic shock wave damage is considered. NSA

N67-38901# Army Edgewood Arsenal, Md. Nuclear Defense Lab.

AN ENGINEERING EVALUATION OF A RADIOACTIVE-WASTE INCINERATOR

David G. Lachapelle *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 509–569 (See N67-38880 23-22)

A 50 lb/hr incinerator and associated gas-cleaning equipment for the concentration of low-level radioactive waste have been evaluated by use of non-radioactive material. Optimum operating

conditions for the incinerator and the gas cleaning equipment have resulted from this investigation. These optimum operating conditions are being employed during the radiological evaluation.
Author (NSA)

N67-38902# Harvard Air Cleaning Lab., Cambridge, Mass.
DISPOSAL OF LOW LEVEL RADIOACTIVE WASTE IN COMMERCIAL INCINERATORS
Melvin W. First, P. Zilles, and J. Walkley *In its* Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 570–585 refs (See N67-38880 23-22)

A comparison was made of the performance of a crematory-type incinerator and a combination steam-boiler incinerator in the combustion of difficult laboratory and hospital wastes such as animals and cage litter. Because of excessive stack emissions of smoke, fly ash, and malodorous gases and vapors, the crematory-type proved unsatisfactory. Under the most favorable operating conditions for avoidance of air pollution and for production of a good quality residue, burning capacity was only 2 to 3 lbs/sq. ft./hr. Higher burning rates produced severe nuisances. The mechanized steam-boiler incinerator, on the other hand, provided a sanitary method for handling and burning such wastes in an efficient and rapid manner. A cyclone dust collector proved superfluous for use with gas or oil fuels and it was found that it could be eliminated without decreasing the overall collection efficiency of an electrostatic precipitator which served as a final cleaning stage.
Author (NSA)

N67-38903# Oak Ridge National Lab., Tenn.
RECENT ADVANCES IN MONITORING OF RADIOACTIVE GASEOUS WASTES AT ORNL
J. F. Manneschmidt *In* Harvard Air Cleaning Lab. Proc. of the 9th AEC Air Cleaning Conf., Vol. 1 Jan. 1967 p 586–612 refs (See N67-38880 23-22)

Many activities at the Oak Ridge National Laboratory are concerned with the chemical processing of radioactive materials. Gaseous effluents from these operations are treated to remove dangerous contaminants prior to release to the atmosphere. Routine monitoring of such emissions was started in 1956 when manually operated particulate monitors were installed at each of three process stacks. Since that date, coverage has been extended to six stacks, the sample withdrawal system has been rebuilt, and the detection equipment has been added to and modernized. The intensive monitoring has led to process improvements which have reduced the environmental releases of radioactivity in the Laboratory's gaseous waste effluents by a factor of three since 1962.
Author (NSA)

N67-38904# Japan Atomic Energy Research Inst., Tokyo.
LIQUID SODIUM TECHNOLOGY DEVELOPMENT. I: TEST LOOPS, PURIFICATION METHODS, AND SUPPLEMENTARY TECHNIQUES
Kazuo Furukawa, Ken Yamamoto, Isao Nihei, and Yae Iguchi Nov. 1965 32 p refs
(JAERI-1129)

The initial results of the development program of liquid Na loops and associated technology are reported for the period 1957 to 1965. Test loops such as corrosion test loop, purification test loop, and mother and daughter test loop system, and their operating experiences are described. In mother and daughter test loop system, various tests are made with daughter test loops, using Na with given contents of impurities which are controlled in the mother loop. Then, the results of development and operating procedures are described for the purification system (cold trap, cold finger, and hot trap). The first model of the cold trap has a Na-oxide removal-capacity of 1.3 kg/30 l. Improvements to this trap are proposed for increasing the capacity to three times the initial one by controlling internal temperature distribution. The results of corrosion and carburization tests are also shown. In the tests, emphasis was placed on austenitic stainless steels (304, 316, 347 S.S.), followed by Cr–Mo steels and refractory metals (Nb, Ta, Mo, Zr, and Ti). The analytical data and behaviors are also described for O, C, etc. in Na.
Author (NSA)

N67-38905# Japan Atomic Energy Research Inst., Tokyo.
WATER CHEMISTRY OF JPDR
Nasumi Ishiwatari Aug. 1966 25 p refs
(JAERI-1135) CFSTI: HC $3.00/MF $0.65

In order to perform more reliable measurements in the chemical aspect of the Japan Power Demonstration Reactor (JPDR), numerous data have been measured since the initial power-up test. The results of these measurements are summarized. From these results, the release rates of radioiodine and metals, such as iron, copper, and nickel, were estimated and analysed. The reliability of the results of the initial power-up test and the excellence of the chemical aspect of this reactor, including the suppression of the release of the radioiodine from the coolant system, the accumulation of corrosion products, and the transfer and deposition of the radioactive nuclides in the coolant system, have been confirmed. The chemical aspects of the JPDR are compared with other boiling water reactors.
Author

N67-38916# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Institut Teoreticheskoi i Eksperimental'noi Fiziki.
DISTRIBUTION ON NEUTRON DENSITY IN THE HETEROGENEOUS REACTOR LATTICE NEAR A WEAK PERTURBATION [RASPREDELENIE NEITRONNOI PLOTNOSTI V RESHCHETKE GETEROGENNOGO REAKTORA VBLIZI SLABOGO VOZMUSHCHENIYA]
A. D. Galanin 1966 26 p refs In RUSSIAN
(NP-16822)

General formulas describing neutron density distributions within a heterogeneous reactor whose lattice has a weak perturbation (control rod) are derived. These formulas are now applied to the determination of the average neutron density at the surface of blocks close to the control rod located at the center of the cell, of the skewing of the neutron density at the surface of blocks close to the control, and of neutron density near the block which differs from other blocks in its properties but is located at one of the lattice points. All theoretical results refer to the control region of a large weakly perturbed heterogeneous reactor and to the case when the internal block effect is sufficiently small. A comparison with known data on heavy water moderated gas-cooled reactors shows a high degree of agreement.
NSA

N67-38924# United Kingdom Atomic Energy Authority, Windscale (England). Production Group.
SOME PRELIMINARY RESULTS AND COMMENTS ON THE USE OF NITROGEN-16 FOR MEASURING CHANNEL OUTLET TEMPERATURE IN GAS COOLED REACTORS
R. L. D. French 1967 18 p refs
(PG-790(W)) HMSO: 2s 6d

An account is given of measurements made of the nitrogen-16 activity of the outlet gas of channels in a Calder reactor. The use of such measurements as an aid to detecting channel blockage is examined. The practicability of correcting for nitrogen-16 decay during transit along the sample-pipe in the Windscale A.G.R. has been assessed. Such a correction is probably necessary in order to increase the accuracy of the nitrogen-16 measurements sufficiently for them to be employed for estimating channel gas outlet temperatures. The effect of nitrogen-16 adsorption in this context is briefly examined. The measurement of channel temperature

using nitrogen-16 activity could assist the on-power optimisation of temperature conditions in Calder type reactors and could also result in savings on future Civil A.G.R.s. Further work is required before the technique could be used in a routine manner on a reactor. Author

N67-38980# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE GEOGRAPHY OF NUCLEAR REACTOR SITES

A. N. Gudkov, V. M. Kolobashkin, V. I. Nekrasov, and N. P. Ushakova *In its* Dosimetry and Radiation Protect. 1966 p 105–108 refs (See N67-38961 23-24)

The pollution of the atmosphere with radioactive gases and aerosols from nuclear reactors is described. The growth of nuclear power reactors for the period 1951 to 1967 is shown graphically. Virtually all nuclear power plants are concentrated in the northern hemisphere. NSA

N67-39134# United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center.

PERFORMANCE EVALUATION OF HEAT EXCHANGERS FOR SODIUM-COOLED REACTORS Quarterly Technical Progress Report, Apr. 1–Jun. 30, 1967

S. L. Israel and D. J. Nolan 20 Jul. 1967 55 p refs

(Contract AT(11-1)-1452)

(UNC-5182) CFSTI: HC$3.00/MF$0.65

The evaluation of the thermal-hydraulic and structural performance of heat exchangers for sodium-cooled reactor plants is presented. The evaluation is based on the results of tests of model heat exchangers in the Sodium Components Test Installation (SCTI). An intermediate heat exchanger and a steam generator are the first units to be tested. Modifications were made to the computer programs for evaluating the thermal-hydraulic performance of the steam generator and intermediate heat exchanger. These corrected procedures were used to calculate new "predicted" performance for each of the test conditions. Calculation of tubesheet stresses for a range of ΔT's larger than expected during the tests was started to allow "on-the-spot" estimates during operation. Temperature distributions in the tubesheet regions were re-examined to define the methods used for estimating structural temperatures for the transient tests and to establish procedures for evaluating test performance. Several new references pertinent to tube vibration were reviewed. A brief study of the stresses in the tack weld of the tubes-to-guide ring in the steam generator indicated that this construction should have infinite fatigue life. However, further review may be necessary after the intermediate heat exchanger tube vibration tests. Calculations were made to compare certain elements of the boiler inlet for the steam generator as rings and as plates with central holes. These indicate that straight ring theory is an unsatisfactory approach. Author (NSA)

N67-39139# AEG-Kernenergieanlagen, Frankfurt am Main (West Germany).

INVESTIGATIONS ON CYCLONES FOR STEAM SEPARATION IN BOILING WATER REACTORS Quarterly Report, Jan. 1–Mar. 31, 1967

31 Mar. 1967 20 p refs

(EUR-3358; EURAEC-1835) CFSTI: HC$3.00/MF$0.65

Investigations into mixture inflow with several rows of steam-separation cyclones located axially to flow in the reactor drop space are detailed. Inflow geometry with mainly horizontal sheet-metal guides to remove a fraction of the mixture flow for each cyclone row were used. The air/water tests in this quarter indicated that sufficiently even mixture distribution could not be guaranteed in all partial load contingencies with adequate certainty. Experimental investigations into mixture distribution were stopped for the moment and cyclone optimisation was initiated. A theoretical investigation intended to: alter the intake geometry to improve mixture distribution; reduce the pressure loss involved in steam removal from the cyclone; to imitate more closely the reactor conditions as regards geometry in the test facility; and simplify separator fabrication. The combination of three steam removal tubes (one from each cyclone row) into a steam removal box was investigated. This assembly did not improve mixture distribution in air/water tests either, even when supplemented with a "compensation section" across the cyclones or a transverse metal-sheet guide. It was, therefore, decided to initiate mixture distribution in the mixture boxes above the core, using appropriate components which constitute a sort of forced mixture guide for each cyclone row. The scope for corresponding tests in the air/water test facility is being explored. Author (NSA)

N67-38143# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.

SOME RESULTS ON THE DEVELOPMENT OF A FAST REACTOR FUEL ELEMENT

K. Kummerer and G. Karsten Apr. 1967 24 p refs Presented at the Brit. Nucl. Energy Soc. Conf. on Fast Breeder Reactors, London, 17–19 May 1966

(KFK-575; CONF-660502-4; EURFNR-312)

The fuels development program for fast breeder power reactors is discussed. Results of testing of fabrication techniques, cladding materials, and development of fuel pins are presented; economics of fast breeder fuels is discussed. The irradiation testing of the fuels is detailed. NSA

N67-39144# Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik.

FABRICATION OF FAST REACTOR FUEL PINS FOR TEST IRRADIATIONS

G. Karsten, Th. Dippel, and H. J. Laue Apr. 1967 16 p refs

(EURFNR-314; KFK-577)

The fabrication of vibratory-compacted UO_2–PuO_2 fuel bearing pins is described under the aspect of test irradiations under the development program of a Fast Breeder Reactor. A design based on theoretical studies and calculation of parameters is needed. A fuel theory is presented, the as-calculated parameters of specific power, diameter, fuel and cladding properties is inserted in formulae, and the maximum available burnup and the density of the fuel pin is found. Then the final design is made. Fuel and cladding selection is done and the materials are tested. Special items of the fuel control are homogeneity of the mechanically mixed UO_2–PuO_2, the Pu-analysis, and the density control. Great efforts have been done on the tubing control. Because of its special problems the vibratory compaction method is described though both it and the pellet line are generally followed in the development program. These special problems are the fuel density, contamination and welding. Author (NSA)

N67-38222# Centro Informazioni Studi Esperienze, Milan (Italy).

DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM–WATER SPRAY TO REACTOR COOLING: INPILE CORROSION OF ZIRCALOY-2 IN STEAM–WATER MIXTURES

E. Cerrai, F. Gadda, and A. Scaroni Oct. 1966 52 p refs *Its* Topical Rept.-7

(Contract EURATOM-058.62.1-RDI)

(EURAEC-1882; EUR-3366) CFSTI: HC$3.00/MF$0.65

The effects of neutron flux on Zircaloy-2 corrosion are measured by in-pile experiments. Results of these tests are presented for given reactor conditions. Effects of temperature on corrosion rate is also shown. Local fast neutron effects are considered. Numerical examples are presented. NSA

N67-38229*# Aerojet-General Corp., Sacramento, Calif.
PHOEBUS-2 MATERIALS Final Report
Sep. 1967 133 p refs
(Contract SNPC-35)
(NASA-CR-89512; RP-SR-0002) CFSTI: HC $3.00/MF $0.65
CSCL 21F

The report documents, in abbreviated form, all metallurgical testing conducted in support of the Phoebus 2 Nozzle Program. The tensile properties of forgings, strip, weldments, and brazements are presented as individual test data and as statistical means with sigma limits through the temperature range of −423 to 1800°F. The mechanical properties of shear strength, bearing strength, low cycle fatigue, and thermal cycling are also presented. In addition, the manufacturing and fabrication processes are presented from raw material melting through fabrication of individual hardware components. Metallurgical analysis of thermal treatments and processing are also provided. Author

N67-39252# Institutt for Atomenergi, Kjeller (Norway).
NORA PROJECT Progress Report, 1 Apr.–30 Jun. 1967
Jul. 1967 16 p refs
(IAEA-3498-18; NC-89) CFSTI: HC $3.00/MF $0.65

Pulsed neutron research, work on grey control elements, and research on cell parameters are discussed. Theoretical methods for the interpretation of the black and grey absorber elements experiments are presented. Reactivity calculations are compared with experimental results. Measurements of the fast advantage factor in light water lattices have continued. Results for the lattice pitch 2.314 cm have been summarized. NSA

N67-39253# Atomic Energy Establishment, Winfrith (England).
SUPERNOVA: AN IMPROVED AND EXTENDED VERSION OF NOVA: A TWO DIMENSIONAL SPATIAL BURNUP CODE
W. G. Clarke May 1967 11 p
(AAEW-M-750) CFSTI: HC $3.00/MF $0.65

Supernova calculates the spatial burnup in a reactor in two dimensions (or 3 dimensions in R-Z geometry) while varying the pattern of the control rods. The code will accept up to 40 neutron groups, giving as output the reactivity, power and burnup distributions at intervals throughout the life of the reactor. It is almost twice as fast as Nova, while providing identical results. Author

N67-39254# Atomic Energy Establishment, Winfrith (England).
BURN-UP PREDICTIONS FOR GAS-COOLED, GRAPHITE-MODERATED REACTORS
J. G. Tyror May 1967 17 p refs Presented at the Intern. Atomic Energy Agency Meeting on Fuel Burn-up Predictions in Thermal Reactors, Vienna, 10–14 Apr. 1967
(AEEW-M-740; CONF-670418-2) CFSTI: HC $3.00/MF $0.65

The theoretical approach currently in use for predicting the burnup characteristics of advanced gas cooled, graphite moderated reactors is outlined. Fuel burnup is computed using the Argosy code, with data derived from the UKAEA Nuclear Data Library; comparisons on a laboratory scale with measurements on samples taken from metal and oxide fuels show that Pu buildup, both in quantity and quality, is well understood. The most significant uncertainty in the theoretical approach is believed to be associated with predicting the variation in power distribution. Author (NSA)

N67-39296# Atomics International, Canoga Park, Calif.
IRRADIATION TEST OF SNAP 8 CANDIDATE SPRING MATERIALS
D. S. Cowgill, N. F. Davies, and W. J. Kurzeka 30 Jun. 1967 37 p refs
(Contract AT(04-3)-701)
(NAA-SR-11519) CFSTI: HC $3.00/MF $0.65

An experiment was conducted to determine the effects of longterm exposure to radiation, high temperature, and vacuum on the performance of two candidate SNAP spring materials. Five René 41(Ni–Cr–Fe) and five Stauffer 880 (88Ta–12W) springs were tested under constant length conditions at temperatures between 700 and 1300°F. Radiation exposures varied from about 2×10^{17} to 3×10^{19} nvt fast neutrons (E>0.1 MeV) and from about 5×10^{5} to 7.5×10^{10}R gamma. Vacuum levels were in the 10^{-4} torr range throughout the approximately 3250-hr experiment. The irradiated spring data were used to calculate the percentage of energy relaxation and percentage of force relaxation for comparison with nonnuclear test data. It was observed that, in all cases, the percent relaxation of irradiated René 41 springs was less than that of the unirradiated springs. No definite pattern was observable with the Stauffer 880 springs, except that high radiation levels increased the percent relaxation (both force and energy), although the effect was minimal at 1300°F. It was concluded, based on these tests, that René 41 springs are superior to Stauffer 880 springs at all test temperatures below ≈1200°F. Above that temperature, the Stauffer 880 springs may be superior. Author (NSA)

N67-39318# California Univ., Livermore. Lawrence Radiation Lab.
CONTRIBUTION TO THE 24TH MEETING OF THE HIGH-TEMPERATURE FUELS COMMITTEE, MAY 16–18, 1967, AT UNITED NUCLEAR CORPORATION, ELMSFORD, NEW YORK
A. J. Rothman, comp. 19 Apr. 1967 25 p refs
(Contract W-7405-ENG-48)
(UCID-15135, Pt. 1) CFSTI: HC $3.00/MF $0.65

Progress on studies of the synthesis and fabrication of UN is reported. Aspects discussed are N diffusion in UN, compressive creep, crystallogenics of UN and refractory materials, kinetics of nitriding, irradiation studies, particle size distribution, and solubility of W in Ag. NSA

N67-39323# Atomics International, Canoga Park, Calif.
THE CALHET HETEROGENEOUS PERTURBATION THEORY CODE AND APPLICATION TO ZPR-3-48
F. L. Fillmore and L. D. Felten 15 Aug. 1967 31 p refs
(AI-67-91)

The effect of geometrical heterogeneities on neutronic calculations for fast critical assemblies is studied. A heterogeneous perturbation theory method developed by F. Storrer, et al, is used to make the calculations. The CALHET code, which is based on this perturbation theory, is described. Calculations are made for the ZPR-3-48 critical assembly and it is found that the effect of heterogeneities in the core of this assembly increase k_{eff} by 1.17% above the value calculated using a homogeneous model of the core. Author

N67-39333# Société Belge pour l'Industrie Nucléaire, Brussels (Belgium).
THE BOILING WATER CAPSULE
A. Lhost Apr. 1967 46 p refs Transl. into ENGLISH from French Supported jointly by US-EURATOM *Its* Spec. Rept.-4
(EURAEC-1867; EUR-3371) CFSTI: HC $3.00/MF $0.65

The "boiling water capsule" is an instrumented experimental device regulated by thermal barrier action. It is designed to study the behavior of fuels subjected to irradiation, and is used for irradiations in the Belgian BR-2 reactor, a high-neutron-flux test reactor using light water for moderation and cooling. The boiling

water capsule permits continuous measurement of the power generated in a fuel rod subjected to irradiation, and enables the can temperature to be held in the vicinity of a given rated value through pressure regulation. Author (NSA)

N67-38344# Kernforschungsanlage, Juelich (West Germany).
DEVELOPMENT OF HIGH TEMPERATURE THERMAL REACTORS IN GERMANY
R. Hecker, W. Rausch, and R. Schulten Brussels, EURATOM, Aug. 1967 33 p refs Presented at the Nucl. Energy Meeting, Milan, 15–17 Dec. 1966
(Contract EURATOM-003-63-1 RGAD)
(THTR-32; EUR-3493.E)

The AVR pebble bed reactor has been completed and the critical experiments have been performed. The work for the development of gas turbines for use with high temperature reactors reached a point where tenders have been submitted for a 25 MWe closed-cycle gas turbine prototype plant. The THTR-Project for the development of a 300 MWe prototype reactor representative of full-scale power plants up to 1200 MWe shall provide final design documents by the end of 1967. Detailed results of these three projects will be transmitted and an outlook on the further development with special regard to the potential for conversion and breeding will be given. Author

23 PHYSICS, GENERAL

Includes acoustics, cryogenics, mechanics, and optics. For astrophysics see: 30 Space Sciences. For geophysics and related information see also: 13 Geophysics; 20 Meteorology; and 29 Space Radiation.

N67-38105# ARO, Inc., Arnold Air Force Station, Tenn.
THE SPECTRAL REFLECTANCE OF WATER AND CARBON DIOXIDE CRYODEPOSITS FROM 0.36 TO 1.15 MICRONS Final Report, 1 May 1965–1 May 1967
B. E. Wood, A. M. Smith, and B. A. McCullough Aug. 1967 48 p refs
(Contract AF 40(600)-1200)
(AEDC-TR-67-131; AD-657018)

The spectral reflectances of water and carbon dioxide cryodeposits were measured in a vacuum integrating sphere as a function of angle of incidence, substrate material, and cryodeposit thickness. Both black paint and a polished copper surface were used as substrates. Measurements were made for wavelengths between 0.36 and 1.15 microns. Cryodeposit thicknesses ranging from 0 to 2.5 mm were investigated. For large cryodeposit thickness, the reflectance was, in general, increased considerably, especially for a black substrate. For thin cryodeposit thicknesses of less than 10 microns, interference patterns were observed. A computer program was written to calculate the energy reflected from cryodeposits for 6000K blackbody irradiation. The reflectance data obtained in the present experiments may be useful for application to thermal models of planetary surfaces such as those of Mars and Venus. Author (TAB)

N67-38199# Southampton Univ. (England). Inst. of Sound and Vibration Research.
ANNUAL REPORT FOR THE YEAR ENDING JUNE 1967
Jun 1967 119 p refs
CFSTI: HC $3.00/MF $0.65

Brief descriptions (abstracts) of work in (1) turbulence structure and statistical characteristics of turbulence, (2) unsteady transfer of properties at a fixed boundary, (3) sound generation in rotating machinery, (4) sound transmission, and (5) aerodynamic noise theory, are presented. Also described are work efforts concerning (1) the vibration of nuclear reactor structures, (2) representation of spatially continuous pressure fields by discrete force systems, (3) response of building structures to sonic booms, (4) fatigue cracks produced by random loading, and (5) acoustic sirens for fatigue facilities. In the study of audiometric techniques, attenuator designs were investigated. Abstracts of other work activities in audiological studies, and industrial acoustics and instrumentation are also presented. L.S.

N67-38287# Naval Research Lab., Washington, D. C.
TABLES OF SPHEROIDAL WAVE FUNCTIONS. PART 3: SECOND VOLUME OF OBLATE RADIAL FUNCTIONS OF THE FIRST AND SECOND TYPE
S. Hanish, R. V. Baier, W. H. Buckler, and Berthel K. Carmichael 24 Apr. 1967 288 p refs
(NRL-6543; AD-656898)

The theory of oblate spheroidal wave functions is briefly reviewed and a list of literature references to applications of oblate spheroidal theory is furnished. Formulas useful for the numerical calculation of oblate radial functions of the first and second type, together with their first derivatives, are derived and explained. A step-by-step procedure of computation is then outlined together with an indication of precision obtained and method of checking. Finally a computer-printout tabulation of 48,600 entries comprising radial functions and their derivatives is reproduced. The range of parameters m, l, g, and xi covered in these tables is m = 0(1)2, l = 9(1)18, g = 0.1(0.1)1(0.2)8, and xi = 0.1(0.1)0.9. Author (TAB)

N67-38296# California Univ., Berkeley. Lawrence Radiation Lab.
REFLECTION OF POLARIZED LIGHT FROM FILM-COVERED SURFACES
J. Richard Mowat and Rolf H. Muller Feb. 1967 73 p refs
(Contract W-7405-ENG-48)
(UCRL-17128) CFSTI: HC $3.00/MF $0.65

Exact equations are derived which relate the (complex) index of refraction and the thickness of a single, absorbing or transparent film on an absorbing or transparent substrate to the changes sustained by polarized light reflected by the film-covered surface. Both film and substrate are assumed to be linear, homogeneous, and isotropic media. Author (NSA)

N67-38331# New York Univ., N. Y. Courant Inst. of Mathematical Sciences.
SPACE–TEMPERATURE CORRELATIONS IN QUANTUM STATISTICAL MECHANICS
William Kunkin and Jerome K. Percus Jun. 1967 78 p refs
(Contract AT(30-1)-1480)
(NYO-1480-74) CFSTI: HC $3.00/MF $0.65

Some approaches used in classical statistical mechanics for deriving integral equations for the pair distribution function are generalized to quantum systems. In the functional differential method, distributions depending on space and temperature arguments are generated from the grand partition function in external field. These distributions are diagonal elements of Green's functions and represent physical quantities when temperature arguments are set equal. A given distribution can be expanded in the external field by means of a functional Taylor series. An integral equation results when the external field is specialized to one arising from a number of fixed particles via their pair interaction with the remaining particles. In this case a distribution in external field may be converted to a higher order distribution for a uniform system. This process is accomplished by using a Feynman path integral representation for all quantities. Classical and quantum statistics are treated. In the former case the problem of bounds on distributions is also investigated. An alternate approach, the potential ensemble method,

applies to Debye–Hückel sequences. Here one, e.g., replaces the actual density (with a particle fixed) by one in which a pair interaction of particles is replaced by an external field, but an ensemble average must be taken over all external fields. A steepest descent calculation enables one to find the pair distribution and best external field self-consistently. The quantum formulation of this method requires all quantities to be expressed on a lattice in occupation representation, in which a lattice site is specified by position in space, temperature, and particle number. Agreement between the two methods described here is indicated. Author (NSA)

N67-38412# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).
MAGNETIC CENTER LOCATION IN QUADRUPOLE LENSES
M. Placidi 17 Jul. 1967 10 p refs Presented at the 2d Intern. Conf. on Magnet Technol., Oxford, Jul. 1967 *Its* Nota Interna No. 371
(LNF-67/47)

The procedure for obtaining rapidly and precisely the magnetic center and axes location in a quadrupole lens is presented. The technique employed uses peaking strips excited by a sinusoidal, fixed frequency magnetic field, oriented along the peaker axis. The apparatus consists of two peakers which can be aligned with the mechanical center of the lens, and an electronic magnetometer working as time–amplitude converter. Alternate methods are described, and the sensitivities and calibration of the instruments are mentioned. The magnetic center of the reference lens was determined with respect to the mechanic center, and the magnetic centers of other lenses were determined in terms of displacement with respect to the reference lens center. The accuracies were found to be of the order of $\pm 2 \times 10^{-2}$ mm. N.E.N.

N67-38421# Argonne National Lab., Ill.
PHYSICS DIVISION SUMMARY REPORT, JANUARY–MARCH 1967
Lowell M. Bollinger Mar. 1967 90 p refs
(Contract W-31-109-ENG-38)
(ANL-7312) CFSTI: HC $3.00/MF $0.65

Short reports on highlights of current research, abstracts or short summaries of oral presentations at meetings, abstracts of papers recently accepted for publication, and publication notices of papers appearing in recent journals and books are included. NSA

N67-38452# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
ERROR ANALYSIS IN CLOCK TRAJECTOGRAPHY [ANALYSE DES ERREURS EN TRAJECTOGRAPHIE A L'HORLOGE]
Robert Galerne and Jacques Zakheim 1967 26 p refs In FRENCH; ENGLISH summary
(ONERA-TN-111(1967)) CFSTI: HC $3.00/MF $0.65

In the first part of this note, the errors on position in clock trajectory are determined as a function of the elementary errors of measurement. The general characteristics of clock trajectography are defined and it is shown that it can improve the radial precision for long range vehicles. A general investigation on the precision of restitution of the velocity vector shows the effect of the errors made on position. In the second part, the method suggested is applied to a typical case. The main causes of errors are analyzed and their effect on the precision of position is examined. Author

N67-38466# Institute for Defense Analyses, Arlington, Va. Research and Engineering Support Div.
LUMINANCE, RADIANCE, AND TEMPERATURE
Lucien M. Biberman Aug. 1967 36 p refs
(Contract DAHC15-67-C0011)
(P-339; IDA/HQ-67-8140; AD-657166)

There are two definitions of light. One concerns human vision and has a set of units and standards based upon psychophysical reactions. The other definition of light is that electromagnetic radiation in the broad spectral region where the principles of optics apply. There are no established standards for the concepts of radiance, irradiance and the related quantities under the second more general definition. This need has been recognized and one effective reference source has been proposed for serious consideration and related reference sources are under development. The appropriate units and reference standards are discussed in terms of present day practice and in terms of the accuracy and precision obtainable. The problem of the apparent discrepancy between the International Practical Temperature Scale and the Thermodynamic Kelvin Temperature Scale, to which the normal references in physics relate, is also discussed. Author (TAB)

N67-38506# California Univ., Berkeley. Lawrence Radiation Lab.
EXCHANGE OF ENERGY BETWEEN TUNGSTEN AT HIGH TEMPERATURES AND GASES AT ROOM TEMPERATURE
Mahn Jick Lim (Ph.D. Thesis) Apr. 1967 98 p refs
(Contract W-7405-ENG-48)
(UCRL-17395) CFSTI: HC $3.00/MF $0.65

The exchanges of energy between a tungsten filament and room temperature neon, nitrogen, argon, krypton, oxygen, nitric oxide, nitrous oxide, mixtures of neon with krypton, and mixtures of argon with oxygen were studied over a wide range of filament temperatures and gas pressures. For non-reactive gases, the thermal accommodation coefficient was found to be independent of gas pressures between 1×10^{-7} and 5×10^{-5} atm and to depend on filament temperatures in a complex manner in the temperature range from 700 to 2800°K. The general trends in temperature dependences of the thermal accommodation coefficients were similar for the noble gases and for nitrogen. The variations for these gases are believed to reflect primarily changes in the fraction of coverage of adsorbed surface impurities and in surface structures. All show maximum thermal accommodation coefficients near 2000°K. For oxygen, below 1500°K, the energy exchange phenomenon was very similar to those for non-reactive gases. In the temperature range from 1500 to 1800°K an exothermic energy exchange occurred that was nearly independent of gas pressure. Above 1900°K, where the exchange was again endothermic, the pressure dependence of the energy exchange became more pronounced as the solid temperature was further raised. At very low oxygen pressures, an abnormally high apparent energy exchange was observed presumably due to instantaneous carbon content change causing an electrical resistance change and due to large errors in the measurement of energy exchange at low pressures. For oxygen, nitric oxide, and nitrous oxide, the energy exchange at about 2600°K was high enough to support the conclusion that essentially all incident molecules react. The energy exchanges of mixtures of neon with krypton were essentially the arithmetic sums of the energy exchanges of the individual species at 2142°K. The same was found for argon–oxygen mixtures at 2528°K. At 1740 and 2200°K, departure from this simple addition rule was found especially for higher oxygen mole fractions. Author (NSA)

N67-38638# Rome Univ. (Italy). Istituti di Fisica.
RELATIVE TIME AND BETHE–SALPETER SOLUTIONS
Q. Bui-Duy 29 Apr. 1967 9 p refs *Its* Note No. 119
(NP-16867)

The physical meaning of the Bethe–Salpeter amplitudes and the role of the relative time in the Bethe–Salpeter equation are investigated. Limitation is made to physical systems whose only kinematical freedom is the time coordinate. Together with time translational invariance, the Bethe–Salpeter amplitude depends

only on $t=t_1-t_2$ which is assumed to be positive. An exactly soluble model is considered. Not only energy eigenvalues are known, but also energy eigenstates are found explicitly in terms of free states. Thus the physical meaning of the Bethe–Salpeter amplitudes becomes apparent once they are found. NSA

N67-38651# Aeronutronic, Newport Beach, Calif.
ABSORPTION BY CO_2 BETWEEN 1800 AND 2850 CM^{-1} (3.5–5.6 MICRONS) Scientific Report
David A. Grywnak, Richard R. Patty, Darrell E. Burch, and Earl E. Miller 15 Dec. 1966 43 p refs
(Contract Nonr-3560(00); ARPA Order 237)
(U-3857; AD-657115)

Transmission spectra in the 1800-2850/cm region were obtained for more than 100 samples of CO2 and CO2 mixed with N2 and A. The spectral resolution was 2.5/cm. Sample pressures varied from 0.0055 to 742 torr with absorber thicknesses covering the range from 0.081 to 84,400 atm cm. Spectra of several samples at the lower pressures show the effect of Doppler broadening. Measurements in the 2400-2560/cm region provide information about the absorption by the extreme wings of collision-broadened lines. Replotted transmission spectra and extensive tables of integrated absorptance for 116 samples are included. Author (TAB)

N67-38719# California Inst. of Tech., Pasadena. Div. of Engineering and Applied Science.
TRANSMISSION AND REFLECTION OF SOUND IN A MEDIA CONTAINING DISCRETE SCATTERERS
David J. McCloskey Aug. 1967 34 p refs
(Contract N00014-67-0094-0009)
(Rept.-85-41; AD-657209)

The problem of the transmission of sound from a plane sound source into a scattering half-space is studied; numerical results are presented for the average sound intensity and current. The reflection of an incident plane wave, inclined at an arbitrary angle to a scattering half-space is considered; an expression for the reflection coefficient, including both the coherent and incoherent reflection of sound, is obtained. The foregoing results are then applied to sound propagation in a liquid containing a large number of small gas bubbles. Author (TAB)

N67-38763# Princeton Univ., N. J. Plasma Physics Lab.
MAGNETIC SURFACES OF L = 3 STABILIZING WINDINGS
G. V. Sheffield *In its* Plasma Phys. Lab. May 1967 p 335–343 refs (See N67-38725 23-25)
(Grant NSF GP-579)

A computer analysis of the magnetic surfaces of a $l=3$ helical stabilizing winding was performed to establish the structure of the magnetic surfaces in the C stellarator, both with and without a transverse field over the circularized stabilizing winding. Considered were various linear, toroidal, and racetrack winding configurations by deriving analytical expressions for their scalar potential and by computing their flux line traces. A racetrack + circularizer + transverse field model gave a fairly accurate representation of the C stellarator. G.G.

N67-38784# Princeton Univ., N. J. Plasma Physics Lab.
DESIGN OF NESTED L=1,2,3, HELICAL WINDINGS TO PRODUCE NEGATIVE V'' CONFIGURATIONS
U. R. Christensen *In its* Plasma Phys. Lab. May 1967 p 344–348 ref (See N67-38725 23-25)
(Grant NSF GP-579)

A field configuration for producing a negative V'' in a stellarator was found by computing the quantitative parameters of three multipolar fields superimposed upon a uniform axial field. Calculations on a straight cylindrical system were extended to a toroidal system by adding a zero-order correction term to the field equations for computed magnetic surfaces inside the separatrix. Well depths of 1% were obtained for the proposed field configuration. G.G.

N67-38773# Princeton Univ., N. J. Plasma Physics Lab.
INSULATION PROBLEMS AT LOW RADIO FREQUENCIES
N. J. Oman *In its* Plasma Phys. Lab. May 1967 p 401–411 refs (See N67-38725 23-25)

Consideration of radio insulations at frequencies up to 200 kHz centered on polyethylene and teflon materials: both have very low dielectric losses, tend to shrink with temperature cycling, have poor resistance to corona attacks, and require liquid or pressurized gas impregnation. Tests on a 15-megawatt rf system showed that cable and potheads which performed well in a ringing circuit failed in pulsed oscillator mode due to longer exposure to corona producing voltages. Utilization of a cast epoxy pothead with a spun copper stress cone and plastic tape insulation for the cable eliminated this problem. G.G.

N67-38829# Massachusetts Univ., Amherst. Polymer Research Inst.
LIGHT SCATTERING BY BANDED SPHERULITES
S. B. Clough, J. J. van Aartsen, and R. S. Stein May 1967 41 p refs
(Contract Nonr-3357(01))
(ONR-TR-90; AD-657351)

Previous studies (see AD-657 351) of light scattering from banded (or ringed) spherulites are extended to: (1) Two-dimensional spherulites having biaxial crystals with helicoidally varying orientation of their optic axes about the radius. Scattering patterns from such spherulites are calculated and prove to be more complex than corresponding patterns from spherulites containing uniaxial crystals. (2) The scattering from two-dimensional spherulites containing helicoidally oriented uniaxial crystals where the spherulite is affinely deformed. Calculated scattering patterns indicate that the HV scattering maxima resulting from this helicoidal orientation which is initially in the form of symmetrical arcs becomes deformed and displaced with spherulite deformation. (3) The case of banded spherulites with step variation of density or orientation of scattering material. This gives rise to higher order scattering maxima (as are experimentally observed) in contrast to the prediction of the existance of only first order maxima for spherulites with uniformly periodic variation in density or orientation. The predictions are compared with theoretical predictions and experimental results for the scattering from circular gratings. Author (TAB)

N67-38935 National Defense Research Organization TNO, The Hague (Netherlands).
CONVERSION TABLES FOR NOISE MEASUREMENT RANGE REPORTS OF SUBMARINES [OMREKENINGSTABELLEN VOOR GELUIDMEETBAANRAPPORTEN VAN ONDERZEEBOTEN]
H. F. Steenhoek 12 Jun. 1967 12 p refs In DUTCH
(Rept.-708.103/2; TDCK-48641)

Tables are given for the conversion of underwater noise levels of submarines in order to facilitate the evaluation of results obtained on various acoustical ranges. The standard reference pressure is $2 \cdot 10^{-5}$ N/m^2 and the standard distance is 100 m in the measured band. Transl. by K.W.

N67-38958# Sandia Corp., Albuquerque, N. Mex.
PULSED ELECTRON BEAM CALORIMETRY UTILIZING STRESS WAVE MEASUREMENTS IN SOLID ABSORBERS

R. A. Graham, R. E. Hutchison, and W. B. Benedick May 1967 15 p refs Presented at the IEEE 9th Ann. Symp. on Electron, Ion, and Laser Beam Technol., Berkeley, Calif., 9–11 May 1967
(Contract AT(29-1)-789)
(SC-DC-67-1791; CONF-670528-1) CFSTI: HC $3.00/MF $0.65

The stress-pulse amplitudes and durations are observed to scale quantitatively with the intensity and energy characteristics of the beams absorbed in various absorbers. The electron-pulse duration is shown as a distinct feature of the stress pulse. It is concluded that measurements of the stress pulses in thick elastic absorbers can provide a basis for calorimetry of pulsed electron beams. It appears that aluminum and X-cut quartz are the best absorber materials for a calorimeter. Aluminum has a much larger thermoelastic constant than quartz, which gives it a superior signal-to-noise ratio. Thus, aluminum is preferable for absorbed energies less than about 8 cal/gram. However, the elastic constants of aluminum are sensitive to temperature rise, and the temperature-independent properties of X-cut quartz absorbers make quartz a better material for higher intensity pulses. Present measurements show that the most desirable gage for the stress-pulse measurements is a guard-ring gage. Author

N67-38959*# Southwest Center for Advanced Studies, Dallas, Tex.
RADIANCE AND POLARIZATION OF MULTIPLE SCATTERED LIGHT FROM HAZE AND CLOUDS
George W. Kattawar and Gilbert N. Plass 20 Sep. 1967 43 p refs Submitted for publication
(Grant NsG-269; Contract AF 19(628)-5039)
(NASA-CR-89284; SR-7) CFSTI: HC $3.00/MF $0.65 CSCL 20F

The radiance and polarization of multiple scattered light is calculated from the Stoke's vectors by a Monte Carlo method. The exact scattering matrix for a typical haze and for a cloud whose spherical drops have an average radius of 12μ is calculated from the Mie theory. The Stoke's vector is transformed in a collision by this scattering matrix and the rotation matrix. The two angles which define the photon direction after scattering are chosen by a random process which correctly simulates the actual distribution functions for both angles. The Monte Carlo results for Rayleigh scattering compare favorably with well known tabulated results. Curves are given of the reflected and transmitted radiances and polarizations for both the haze and cloud models and for several solar angles, optical thicknesses, and surface albedos. The dependence on these various parameters is discussed. Author

N67-39064# National Physical Lab., Teddington (England).
THE AIRBORNE SOUND INSULATION OF PARTITIONS
E. N. Bazley 1966 61 p refs
HMSO: 5s

Measurements of the sound insulation of partitions were carried out under reverberant sound conditions in specially designed transmission rooms. Results are compiled for use of manufacturers, architects, and others concerned with sound insulation. Theoretical considerations of single- and double-leaf partitions are presented, and laboratory measurements are examined with respect to method and accuracy. Various types of partitions are discussed including: metal office-type partitions, stud and double partitions, boards on battens on brickwork, windows and doors, and doors and windows in brickwork. It was found that the insulation characteristics of partitions vary markedly, particularly with respect to type of construction. For partitions with the same superficial weight, the insulation values are likely to be similar at low frequencies, whereas at high frequencies a double construction is usually appreciably better than a single construction. Porous materials are comparatively poor insulators, and therefore structurally suitable materials such as clinker concrete and wood-wool slabs should be rendered to provide adequate sealing. The distinction between sound insulating constructions and sound absoring materials is emphasized, and it is stated that the sound absorption coefficient of a material or construction is not a measure of its efficiency as a partition. S.P.

N67-39118# California Univ., Livermore. Lawrence Radiation Lab.
SHOCK-INDUCED DEMAGNETIZATION OF NICKEL FERRITE, YTTRIUM IRON GARNET, AND IRON
E. B. Royce 1 Jun. 1967 17 p refs Presented at the IUTAM Symp. on Behavior of Dense Media under High Dyn. Pressures, Paris, 11–15 Sep. 1967
(Contract W-7405-ENG-48)
(UCRL-70240; CONF-670914-4) CFSTI: HC $3.00/MF $0.65

The demagnetization of samples of nickel ferrite, yttrium iron garnet, and iron on shock compression has been measured as a function of pressure and biasing field. In low-field experiments, the shock-induced reduction in magnetic flux through the sample was detected by pickup coils wound on ferrite bars completing the magnetic circuit between the sample and biasing permanent magnet. In high-field experiments, a pulsed solenoid was used to bias the sample. The magnetization was always biased in a direction transverse to the shock-propagation direction, and only the change in the transverse component was measured. For the ferrimagnetic ceramics nickel ferrite and yttrium iron garnet, the change in magnetization is due to the combined effects of (A) the shift in Neel temperature with compression and the temperature rise associated with shock compression, and (B) a shock-induced longitudinal magnetic anisotropy associated with the shock-induced anisotropic microscopic strain. Author (NSA)

N67-39127*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
X-RAY OPTICS, PART I
J. Mangus Sep. 1967 69 p refs
(NASA-TM-X-55952; X-263-67-493) CFSTI: HC $3.00/MF $0.65 CSCL 20F

This report is primarily concerned with the elementary theory and design of a two element glancing incidence telescope. The X-ray telescope experiment for ATM, a Type 1 telescope (concave parabola followed by a concave hyperbola), is analyzed using a modified ray tracing program outlined by Wolter. It is shown that the image quality of such a system can be significantly improved by matching the detector to the optimum focal surface and by vignetting rays which contribute to the flare in comatic images. Vignetting is accomplished by reducing the hyperbola element to approximately one half of its length from an unvignetted configuration. The total weight of the hyperbola element is, therefore, reduced by one half, resulting in a savings of material cost and fabrication time. The imaging properties of a one-third scale ATM type telescope are discussed. Author

N67-39131# Michigan Univ., Ann Arbor.
A NEW EXPERIMENTAL TEST OF COULOMB'S LAW OF FORCE BETWEEN CHARGES
Gary Don Cochran (Ph.D. Thesis) 1967 228 p refs
(Contract AT(11-1)-1112)
(COO-1112-118) CFSTI: HC $3.00/MF $0.65

An investigation was made of the exponent in Coulomb's law of force between point charges. In 1936 S. J. Plimpton and W. E. Lawton established a value for this exponent of $2(1\pm10^{-9})$. The experiment performed by Plimpton and Lawton is analyzed and methods of refining the experiment are presented. Sophisticated voltage detection and data processing techniques are discussed which provide significant improvements in the experiment. The existence of spurious effects created difficulties in determining a new value for the exponent with the experiment. These spurious

effects are discussed and their origins are investigated experimentally. Because of these effects two values are reported for the exponent. The first is $2(1\pm2.3\times10^{-11})$ which represents a "limit of error" for the experiment and the second is $2(1\pm4.6\times10^{-12})$ which represents our estimate of the "70% confidence interval." Results are applied to a recently reported discrepancy between experimental and theoretical values for the Lamb shift. It is shown that an exponent violation of Coulomb's law, within the experimental bounds now established, cannot account for this discrepancy. Theoretical calculations required for analysis of the experimental data also yield a new approximation to the charge distribution on a cubic conductor for the usual Coulomb inverse square law of force. The capacitance of a cube with side length a is obtained from the charge distribution and the result is 0.6596 a esu. Author (TAB)

N67-39171 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

SOLUTION OF AN OPTIMUM PROBLEM OF KINETICS QUICKEST OF A POINT OF VARIABLE MASS BY THE METHOD OF DESCENT [RESHENIYE ODNOY OPTIMAL'NOY ZADACHI DINAMIKI TOCHKI PEREMENNOY MASSY METODOM SKOREYSHEGO SPUSKA]

Yu .V. Kozhevnikov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 13–22 refs (See N67-39169 23-32)

Consideration is given to the solution of certain optimum control problems concerned with the kinetics of particles having piecewise-continuous changes of mass. The problem consists of the selection of control functions, boundary values of time, coordinates, and the mass of the point on sections of the trajectory. The methods of quickest descent is applied in which the trajectory consists of only two sections. C.T.C.

24 PHYSICS, ATOMIC, MOLECULAR, AND NUCLEAR

Includes atomic, molecular, and nuclear physics. For applications see: 22 Nuclear Engineering. For related information see also: 29 Space Radiation.

N67-38074# Atomic Energy of Canada, Ltd., Chalk River (Ontario).

THE PENETRATION OF KEV PROJECTILES IN SOLIDS [PENETRATION DES PROJECTILES KEV DANS LES SOLIDES]

J. A. Davies Aug. 1967 15 p refs Presented at the Am. Soc. for Testing Mater. 15th Ann. Conf. on Mass Spectrometry and Allied Topics, Denver, 14–19 May 1967
(AECL-2757) CFSTI: HC $3.00/MF $0.65

During the past five years, a large amount of experimental information on the penetration of energetic (0.5–500 keV) ions in solids has been obtained. The technique consists in bombarding the solid with a mono-energetic beam of radioactive ions, and then subsequently measuring the depth distribution of the embedded radioactivity by a high precision ($\approx \pm10$ Å) sectioning technique. Results are summarized and compared with Lindhard's theoretical predictions. In amorphous targets, the agreement between experiment and theory is quite good—i.e., within ±20%. In oriented crystalline targets, however, the mean penetration is increased by up to a factor of 10, due to "channeling" of the beam along the open directions or planes in the lattice. The dependence of this channeling effect on the enrgy and atomic number of the projectile has been investigated thoroughly; also its dependence on radiation damage, surface imperfection and misalignment of the crystal has been studied. Author

N67-38131# Physical Studies, Inc., Reno, Nev.

CERTAIN COLLISIONS BETWEEN PROTONS AND DIATOMIC MOLECULES Final Report, 15 Mar. 1965–31 May 1967

R. G. Breene, Jr. 31 May 1967 64 p refs
(Contract AF 19(628)-5174)
(PSI-67-10; AFCRL-67-0352; AD-655911)

The general description of proton-homonuclear diatomic molecule collisions is formulated in impact parameter language. A solution of the resulting Schroedinger equations through the second iteration is used for the ab initio calculation of the proton-nitrogen charge exchange cross section. The agreement with experiment is essentially exact although this may be fortuitous. The first iterative solution is used to compute the nitrogen-proton dissociative charge exchange cross section. The poor agreement with experiment could apparently be much improved by the consideration of translational energy exchange. The proton excitation of the Schumann-Runge system is considered in the tracking approximation. The agreement with Green is better than would have been expected. A crude classical explanation of the temperature effect near threshold in nitrogen-electron ionizing collisions is suggested. Author (TAB)

N67-38158# Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.

LIMITATIONS OF PION POLE DOMINANCE

B. Renner May 1967 6 p refs
(Grant AF-EOAR-65-36)
(AFOSR-67-1652; AD-655877)

An examination was made of the vertex of the electromagnetic current and an axial current divergence between <pi(+)k(p)/and the vacuum, approximated by a pion pole. The results indicate that pion pole dominance cannot be used without limitations. TAB

N67-38173# Cambridge Univ. (England). Dept. of Applied Mathematics and Theoretical Physics.

WEINBERG SUM RULES AND SCALAR MESONS

S. P. De Alwis Jun. 1967 12 p refs
(Grant AF-EOAR-65-36)
(AFOSR-67-1630; AD-655879)

A generalization was made of the Weinberg sum rules to SU(3) x SU(3) by including scalar meson states and it was found that the second sum rule or at least its saturation with low lying-resonances is not consistent with experimental data. Hence instead the experimental decay widths of Rho and K* are used together with the first sum rule to obtain predictions for the decays widths of a proposed scalar meson. Author (TAB)

N67-38187# California Univ., Livermore. Lawrence Radiation Lab.

TRANSMISSION OF 14-MeV NEUTRONS IN LIQUID NITROGEN

Myron Heusinkveld 9 Jun. 1967 23 p refs
(Contract W-7405-ENG-48)
(UCRL-50259)

The range of neutrons from a 14-MeV neutron source in liquid nitrogen was measured with various neutron detectors. The distance over which the flux of high-energy neutrons is attenuated by a factor of e was measured to be 36±2 cm. Some results are also presented for lower-energy neutrons. Author (NSA)

N67-38190# Imperial Coll. of Science and Technology, London (England). Dept. of Physics.
COVARIANT PROPAGATORS AND VERTEX FUNCTIONS FOR ANY SPIN
Michael Scadron May 1967 33 p refs
(Grant AF-EOAR-67-12)
(AFOSR-67-1609; AD-655886)

High spin wave function, propagators and vertex functions are developed in a covariant on-shell manner. General formulae are given for massive bosons and fermions and for photons. Application to dispersion theory is discussed. Author (TAB)

N67-38200 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France). Faculte des Sciences.
THINGS, STRUCTURES AND PHENOMENA IN QUANTUM PHYSICS
Bernard d'Espagnat [1967] 11 p refs Presented at the 3d Intern. Congr. for Logics, Methodology and Philosophy of Sci., Amsterdam, Aug.–Sep. 1967
(TH-213)

Questions of semantics in the interpretation of scientists of scientific terms relating to the general rules of conventional quantum mechanics are discussed. The words: scientific, structure, weak or intersubjectively, happening, phenomenon, reality, classical, unirealism, are discussed. L.S.

N67-38207*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE RADIATION LENGTH
A. A. Pomanskii and O. I. Dovzhenko *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 63–85 refs (See N67-38201 23-29)

The introduction of a radiation length or cascade unit, which makes it possible to solve cascade equations, is discussed. It is pointed out that the energy losses of high energy electrons and photons passing through matter are mainly caused by bremsstrahlung and pair production. Expressions are developed for the cross sections for bremsstrahlung and pair production in a field of atomic electrons. The radiation logarithm, allowing for the effect of total screening, and corrections for the inaccuracy of the Born approximation are also discussed. Values of calculated cascade units are tabulated and are considered to agree with experimental data. N.E.N.

N67-38211*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE μ-MESON SPECTRUM FOR ENERGIES FROM 10^{11} TO 10^{13} EV AT SEA LEVEL
D. D. Krasil'nikov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 118–132 refs (See N67-38201 23-29)

The integral energy spectrum of muons were determined from large ionization burst data obtained using spherical high pressure chambers. Graphs are presented of the spectrum of muon-caused ionization bursts, and of integral energy spectra of global and vertical muon flux at sea level. Results are summarized and include expressions for the spectra. It is also concluded that muons with energy less than about 2×10^{12} eV may be products of the decay of pions created during the nuclear interactions of primary particles. N.E.N.

N67-38226*# Israel Program for Scientific Translations, Ltd., Jerusalem.
COUPLING COEFFICIENTS FOR PARTICLE PASSAGE THROUGH THE ATMOSPHERE, TAKING INTO ACCOUNT NUCLEAR INTERACTIONS
E. G. Boss, L. I. Dorman, E. V. Kolomeets, and Zh. S. Takobaev *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 237–245 refs (See N67-38201 23-29)

A mathematical discussion is presented of the passage of a meson through the atmosphere, taking into account the cascade multiplication of the nuclear active component production by collision with the nucleus of an air atom. The method is developed assuming that the primary is a nucleon and that first only pions are produced by the collisions, and it is extended to include muons. The probability that the mesons will reach specified heights is treated, and equations are given for the coupling coefficients for positive and negative pions and for muons. N.E.N.

N67-38239# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
STUDY OF THE FAST COINCIDENCE (n, He^3) IN (d,d) REACTIONS. MEASUREMENT OF VARIOUS TOTAL CROSS SECTIONS [ETUDE DE LA COINCIDENCE RAPIDE (n, He^3) EN REACTION (d,d). MESURES DE DIVERSES SECTIONS EFFICACES TOTALES]
Claude Thibault (Ph.D. Thesis—Paris Univ., Orsay, France, 8 Oct. 1965) 1967 63 p refs In FRENCH
(CEA-R-3124)

The neutron total cross sections of ^{27}Al, ^{9}Be, ^{52}Cr, ^{59}Co, ^{69}Ga, ^{58}Ni, ^{238}U, and ^{51}V were measured in the neutron energy range of 3 MeV using the associated-particle method. A CsI(Tl) scintillator coupled to a photomultiplier was used to detect the charged particles. The kinematics of the reactions D(d,p)T and D(d,n)^{3}He are studied, together with the shape of the time spectra. NSA

N67-38242# Imperial Coll. of Science and Technology, London (England).
THE RESONANCE APPROXIMATION IN SUPERCONVERGENCE RELATIONS
R. J. Rivers Jun. 1967 17 p refs
(Grant AF-EOAR-12-67)
(ICTP/67/27; AFOSR-67-1642; AD-655882)

Assuming an exponential fall-off in elastic widths along a Regge trajectory (as suggested by both experiment arid theory), it is suggested that any amplitude satisfies high (perhaps arbitrarily high) moment superconvergence relations in a resonance approximation. The experimental data is consistent with the existence of zeroth and second moment sum rules for the Pi–N and spin–flip amplitude. Author (TAB)

N67-38256 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France). Faculte des Sciences.
PHOTON MESO-PRODUCTIONS AND ELECTROMAGNETIC COUPLINGS OF BARYONIC RESONANCES
F. M. Renard and Y. Renard Jul. 1967 35 p refs
(TH-210)

Reactions involving production of photons meson + nucleon $\rightarrow \gamma$ + baryon, are studied for the determination of the electromagnetic couplings of the (M–N) resonances with charge zero and strangeness equal to zero or minus one. As illustrations the cases of the first N^{*0} resonances appearing in $\pi^- + p \rightarrow \gamma + n$ and of the Y^{*0} resonances appearing in $K^- + p \rightarrow \gamma + \Lambda$ are treated. We show how these reactions may be used to test the isospin properties of the electromagnetic interactions, the predictions of quark models, SU(3) symmetry and other models for the classification and for the electromagnetic couplings of the baryonic resonances. Lastly, the reactions with deuteron target M + d $\rightarrow \gamma$ + B + N are shown to be particularly sensible to the baryon–nucleon interactions. Auther

N67-38288# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
STUDY OF NEUTRONS RESONANCES FOR NUCLEI OF SPIN 1/2 (SILVER, THULIUM, PLATINUM) BETWEEN 1 AND 800 eV [ETUDE DES RESONANCES DE NEUTRONS EN FONCTON DE LEUR SPIN POUR LES NOYAUX 1 = 1/2 (ARGENT, THULIUM ET PLATINE) ENTRE 1 ET 800 eV]
Solange May de Barros (Ph.D. Thesis—Paris Univ., Orsay, France, 26 Apr. 1966) 1967 67 p refs In FRENCH
(CEA-R-3077)

The parameters of 239 resonances in Pt, ^{195}Pt, ^{107}Ag, ^{109}Ag, and ^{169}Tm were determined on the basis of capture and transmission experiments. Spin assignments were made for 120 of these resonance levels. It was found that the ratio of the average spacing of each spin state obeys the law 2J + 1. The density function appears to be independent of the spin 0 or 1 of the compound nuclei for target nuclei with I = 1/2. NSA

N67-38272# Naval Ordnance Lab., White Oak, Md.
APPLICATION OF THE PARTICLE-HOLE MODEL TO ELECTROEXCITATION AND MUON CAPTURE IN LIGHT NUCLEI
Lemmuel L. Hill 24 May 1967 131 p refs
(NOLTR-67-88; AD-656901)

In the framework of the one-particle, one-hole model with a Serber residual interaction the negative parity J = 0, 1 and 2, T = 1 eigenstates are calculated. These results are then used to determine the E1 and M2 squared reduced matrix elements for inelastic electron scattering for values of momentum transfer from 0 to 300 MeV/c. The nucleon decay widths of the 1(-) and 2(-) states are calculated from R-matrix theory and used in conjunction with the E1 and M2 matrix elements and the Breit-Wigner formula to determine the excitation spectra for photonuclear and 180 deg. inelastic electron scattering reactions. In addition, the matrix elements for muon capture are calculated for all three couplings and the total muon capture rate is determined. Results are presented for each of the five, light, magic number nuclei 12C, 16O, 28Si, 32S, and 40Ca. Author (TAB)

N67-38295# California Univ., Berkeley. Lawrence Radiation Lab.
BISE—A TWO-VERTEX KINEMATIC PROGRAM
Harold Hanerfeld 28 Mar. 1967 31 p
(Contract W-7405-ENG-48)
(UCRL-17473) CFSTI: HC $3.00/MF $0.65

BISE is a two-vertex kinematic least-square program written specifically for fitting events of the type $K^- + p \rightarrow \Sigma^+ + \pi^- + \pi^0$ and $K^- + p \rightarrow \Sigma^+ + \pi^-$, where $\Sigma^+ \rightarrow p + n^0 + \pi^+ + n$. A complete description of the mathematical formulation on which the program is based is presented. Author (NSA)

N67-38307# Instituto de Investigacion Aeronautica y Espacial, Buenos Aires (Argentina).
RATIOS OF E2 TRANSITION PROBABILITIES OF DEFORMED EVEN-EVEN NUCLEI
S. M. Abecasis and H. E. Bosch Mar. 1967 39 p refs
(Grant DA-ARO-49-092-66-G121)
(LR17; AD-656790)

Several ratios of E2 transition probabilities between levels belonging to the ground-state, beta- and gamma-rotational bands in deformed even-even nuclei are numerically calculated within the framework of the rotation-vibration interaction model. A detailed comparison of the theoretical predictions with available experimental data is performed. The conclusion can be drawn that this model gives at the present one of the best agreement with experiment without the introduction of empirically determined parameters. Author (TAB)

N67-38311# Argonne National Lab., Ill.
ON THE STRUCTURE OF THE ISOTROPIC TRANSPORT OPERATORS IN THREE INDEPENDENT SPACE VARIABLES
Erwin H. Bareiss and Ibrahim K. Abu-Shumays May 1967 66 p refs
(Contract W-31-109-ENG-38)
(ANL-7328) CFSTI: HC $3.00/MF $0.65

Based on the idea of separation of variables, a spectral theory for the three-dimensional, stationary isotropic transport operator is presented in a vector space of complex-valued Borel functions resulting in continuous sets of regular and generalized eigenfunctions. Because of the non-self-adjoint nature of this operator, the results could not be anticipated intuitively from the known decomposition of this operator in the special case of plane geometry. The results obtained indicate a promising new approach to the analytic solution of the linear transport equation in higher space dimensions. Examples are given for slab geometry with and without axial symmetry, spherical symmetry, and cylindrical symmetry.
Author (NSA)

N67-38315 European Organization for Nuclear Research, Geneva (Switzerland).
THE K^oR^o SYSTEM
G. Charpak and M. Gourdin (Lab. de Phys. Theorique et des Hautes Energies) 11 Jul. 1967 102 p refs Lectures held at the Matsci. Inst., Madras, Dec. 1966 and Jan. 1967
(CERN-67-18)

A general analysis of neutral kaon physics is presented, and specific experiments and their theoretical significance are discussed in detail. The $K^o\overline{K}^o$ system under the assumption of CP invariance is described, along with kaon decay and interactions with matter. Strong electromagnetic and weak interactions are investigated, and discrete symmetries are considered. Unitarity conditions are covered, and an isotopic spin analysis is given. The violation of CP invariance is illustrated. The TCP and time invariances are studied. Calculations and properties of kaons are appended. N.E.N.

N67-38319# National Inst. for Research in Nuclear Science, Harwell (England). Rutherford High Energy Lab.
THE WORK OF THE RUTHERFORD LABORATORY IN 1966
F. M. Telling, ed. May 1967 86 p refs
(RHEL/R-144) CFSTI: HC $3.00/MF $0.65

The work of the following divisions of the Rutherford High Energy Laboratory is reported in detail: High Energy Physics, Nimrod, Applied Physics, Proton Linear Accelerator, Engineering, Administration. Lists of publications by the staff are included. Separate abstracts are prepared for the first four sections. NSA

N67-38320*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
MECHANISM OF DEUTERON BREAKUP BY 42-MeV ALPHA PARTICLES
Robert E. Warner and Robert W. Bercaw Washington, NASA, Oct. 1967 17 p ref
(NASA-TN-D-4202) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Coincidence measurements of absolute cross sections for the breakup of deuterons by 42-MeV alpha particles have been made. The alpha-particle energy spectra show large peaks due to final state interactions (FSI) through the helium 5 and lithium 5 ground states. Plane wave impulse approximation calculations correctly predict the existence of additional peaks for small spectator neutron energies, but otherwise give bad fits to the observed spectra. In general, the yields in the spectator peaks exceed those in the FSI peaks. Especially large cross sections, approximately 1 barn per square steradian (100 fm^2/sr^2) (integrated over alpha energy), are observed when kinematic conditions are such that alpha plus proton can form the lithium 5 ground state, with the

neutron left as a spectator. Analysis of the more prominent FSI peaks yields a binding energy and width of -0.88 ± 0.12 and 0.75 ± 0.20 MeV, respectively, for the ground state of helium 5; the corresponding figures for lithium 5 are -1.9 and 1.4 MeV. Author

N67-38344# Atomic Energy Commission, Washington, D. C. Technical Information Div.
SUMMARIES OF RESEARCH IN HIGH ENERGY PHYSICS
Jul. 1967 150 p refs
(TID-4005, Pt. 6, Rev.) CFSTI: HC $3.00/MF $0.65

Summaries of high energy physics research conducted at various laboratories and universities are presented. This revision includes a principal investigator index and a supplemented subject index. NSA

N67-38354# Atomic Energy of Canada, Ltd., Chalk River (Ontario).
COSMIC RAY NM-64 NEUTRON MONITOR DATA. VI: MONTHLY GRAPHS, JANUARY–APRIL 1967
J. F. Steljes May 1967 85 p refs
(AECL-2703; CRGP-1259) CFSTI: HC $3.00/MF $0.65

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from January to April 1967. Normalized graphs are given for the period January to April 1967. The five-minute results for the solar-particle event of January 28, 1967, and a warning about a spurious annual variation are included. Author (NSA)

N67-38357# Oak Ridge National Lab., Tenn.
NEUTRON CAPTURE CROSS SECTIONS AND THE s-PROCESS
J. H. Gibbons and R. L. Macklin [1967] 41 p refs Presented at the Symp. on the Origin and Distribution of the Elem., Paris, 8–11 May 1967
(Contract W-7405-ENG-26)
(ORNL-P-3052; CONF-670524-1) CFSTI: HC $3.00/MF $0.65

Correlations were found between element abundance and neutron capture cross sections at energies corresponding to interior stellar temperatures and demonstrated the validity of the s-process theory of heavy element nucleosynthesis, disclosing the form of the neutron flux to which the solar system materials have been exposed. Tests using separated isotopes have bypassed the sometimes large uncertainties in elemental abundance and have shown, in some cases, highly quantitative agreement s-process calculations. Alternative abundance correlations, such as with neutron binding energy, were tested and were found to show no significance. NSA

N67-38371# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
THE CASIMIR OPERATORS FOR THE GROUP O(n) [OPERATORY KAZIMIRA DLYA GRUPPY O(n)]
A. V. Nikolov 1967 19 p refs In RUSSIAN
(JINR-P2-3334)

A method of finding the eigenvalues of the Casimir operators of an arbitrary order for group O(n) is developed; the formulas defining the irreducible representations of O(n) obtained by Gel'fand and Zetlin are used. The suggested method essentially differs (due to the specific features of the above mentioned formulas) from that applied by Perelomov and Popov for the same purpose. The results essentially differ as well (the definitions of the Casimir operators are different); the result obtained here is more effective. Author (NSA)

N67-38372# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
ON THE ACCOUNT OF THREE-PARTICLE FORCES BY QUARKS IN HIGH ENERGY HADRON SCATTERING [OB UCHETE TREKHCHASTICHNYKH SIL MEZHDU KVARKAMI PRI VYSOKOENERGETICHESKOM RASSEYANII ADRONOV]
R. P. Zaikov and D. Ts. Stoyanov 1967 9 p refs In RUSSIAN
(JINR-P2-3359)

A possibility is considered of obtaining the relations between the total scattering cross sections as well as between differential cross sections of some inelastic hadron collisions, considering that the quark forces are three-particle and the quark–antiquark ones paired. Author (NSA)

N67-38373# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
MECHANISM OF INTERACTION OF FAST DEUTERONS WITH NUCLEI [MEKHANIZM VZAIMODEISTVIYA BYSTRYKH DEITRONOV S YADRAMI]
V. S. Barashenkov, K. K. Gudima, and V. D. Toneev 1967 18 p refs In RUSSIAN Submitted for publication
(JINR-P2-3356)

A method of calculation of inelastic collisions of deuterons with nuclei is suggested. The calculation is made by the Monte Carlo method taking into account the Coulomb and diffraction deuteron splittings. The results of calculations agree well with experiment. Author (NSA)

N67-38375# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems.
FLUCTUATIONS OF IONIZATION LOSSES (TABLES) [FLYUKTUATSII IONIZATSIONNYKH POTER' (TABLITSY)]
B. M. Golovin, L. A. Kulyukina, S. V. Medved, P. Pavlovich, and P. Shulek 1967 180 p refs In RUSSIAN
(JINR-P1-3190)

The functions for the ionization loss distribution of heavy charged particles in Be, C, CH, CH_2, Al, Cu, and Pb are tabulated in wide intervals of particle energy and stopping-material thickness. Author (NSA)

N67-38379*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
THE EQUILIBRIUM THERMODYNAMIC PROPERTIES OF A HIGH-TEMPERATURE NITROGEN–ALKALI-METAL VAPOR MIXTURE
Stephen K. Park Washington, NASA, Oct. 1967 68 p refs
(NASA-TN-D-4108) CFSTI: HC $3.00/MF $0.65 CSCL 20M

A study has been made of the equilibrium thermodynamic properties of nitrogen seeded with alkali-metal vapor at high temperatures (1000° K to 20,000° K), moderate pressures (0.003 to 3 atmospheres), and 0 to 5 percent seeding. It was found that because of the low ionization potentials of the seed materials, their ionization could represent a significant energy sink in regions where nitrogen is essentially chemically inactive. In addition, the increased number density of electrons resulting from ionization of the seed material caused a delay, until a higher temperature, in the ionization of nitrogen. These two effects tend to produce, for a given seed material, rather well-defined temperature-pressure regions in which even small degrees of seeding produce fairly large variations in some thermodynamic properties. In other regions, if proper allowances are made for the change in the average atomic weight of the mixture (and consequently, a change in the gas constant of the mixture) caused by the mass fraction of seed material, the effect of seeding is found to be very small even for as much as 5 percent seeding. In general, it was found that the effect of seeding on the thermodynamic properties of the mixture tends to become more pronounced at lower pressures. Also, as might be expected, the effect usually becomes more pronounced as the seeding percentage is increased. Author

N67-38382# Maryland Univ., College Park. Dept. of Physics and Astronomy.
LOW ENERGY (Σ^+, p) AND (Σ^-, p) ELASTIC SCATTERING
H. A. Rubin (Ph.D. Thesis) and R. A. Burnstein (Illinois Inst. of Tech.) Feb. 1967 31 p refs
(Contract AT/40-1/-2540)
(ORO-2504-103; TR-655) CFSTI: HC $3.00/MF $0.65

The cross sections for the elastic scattering of Σ^+ and Σ^- hyperons on protons were measured. The hyperons were produced by the interactions of stopping K^- mesons in a hydrogen bubble chamber. The cross section for (Σ^-,p) elastic scattering is 166±33 mb, at a mean laboratory momentum of 150 MeV/c. The cross section for (Σ^+,p) elastic scattering is 84±34 mb at a mean laboratory momentum of 161.5 MeV/c. These measurements, as well as the results of similar experiments, are compared with several recent theoretical predictions of hyperon nucleon scattering cross sections. Author (NSA)

N67-38418# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
MAGNETIC SMALL ANGLE SCATTERING OF THERMAL NEUTRONS IN UNMAGNETISED IRON [MESSUNG DER MAGNETISCHEN KLEINWINKELSTREUUNG THERMISCHER NEUTRONEN AN UNMAGNETISIERTEM EISEN]
J. N. Mathur Apr. 1967 26 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-37)

When a well collimated beam of thermal neutrons is passed through samples of unmagnetized iron, the beam is found to diverge in very small angles of the order of minutes. But as soon as the samples were slightly magnetized the broadening of the beam disappeared. The purpose of this work was to find out the cause of this broadening of the beam. The experimental results were compared with the two contradictory theories (refraction or diffraction) and it was found that for the domain size and the neutron wavelength under consideration, the cause of the small-angle scattering was refraction of neutrons at domain boundaries. Author

N67-38426# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
POLARIZATION IN π-e SCATTERING AND ELECTROMAGNETIC FORM FACTOR IN π-MESON [POLYARIZATSIYA V π-e-RASSEYANII I ELEKTROMAGNITNYI FORMFAKTOR π-MEZONA]
S. M. Bilen'kii and V. B. Semikoz 1967 10 p refs In RUSSIAN Submitted for publication
(JINR-P2-3338)

Electron polarization in π-e-scattering in the energy region up to the π+e→2π+e reaction threshold is calculated. In this region the polarization is determined by the meson (π) electromagnetic form factor. Author (NSA)

N67-38427# Comitato Nazionale per l'Energia Nucleare, Rome (Italy).
EVALUATION OF RESONANCE INTEGRALS OF FISSION PRODUCT NUCLEI [VALUTAZIONE DEGLI INTEGRALI DI RISONANZA DEI NUCLEI PRODOTTI DA FISSIONE]
M. A. Palmucci 1967 14 p refs In ITALIAN
(RT/FI-(67)-4)

The resonance integrals of some fission-product nuclei are evaluated by means of the most recent single-level resonance parameters. Calculated values are compared, whenever possible, with experimental values. Author (NSA)

N67-38430# California Univ., Berkeley. Lawrence Radiation Lab.
ACCURACY OF VERY-HIGH-ENERGY RADIATION MONITORING
H. Wade Patterson May 1967 11 p refs Presented at the Symp. on Radiation Dose Meas., Their Purpose, Interpretation and Required Accuracy in Radiological Protect., Stockholm, 12–16 Jun. 1967
(Contract W-7405-ENG-48)
UCRL-17412; CONF-670621-2) CFSTI: HC $3.00/MF $0.65

In order to ensure suitable accuracy in health physics measurements of very-high-energy radiation, it is first necessary to lay a proper foundation of knowledge and understanding of the radiation field. This should be done by choosing detectors and analyzing systems that are selective in their response to the radiation of interest and with satisfactory sensitivity. In complex radiation fields, such as those produced by particle accelerators, it is necessary to use several detectors, each with its own range of response and sensitivity. For example, to evaluate the radiation field produced by a proton accelerator of more than 500-MeV energy the neutron energy spectrum must be measured with a series of different detectors whose energy threshold and response as a function of energy are well known. Statistical accuracy in these measurements is based on reducing background in the detection system and controlling its fluctuations. In addition, sensitivity should be such that count rates and signal-to-noise ratios are large. This usually means a large volume or mass of detector. Experimental accuracy is based on knowing the response of the detector as a function of energy, both as regards selectivity and sensitivity. Experimental parameters and operating conditions of the accelerator should be varied, to check for reasonable variations in detector response. Proper monitors should be used so that data taken at different times can be normalized. Results from different detectors should be compared for consistency and compliance with physical principles. After the radiation field is described in physical terms, i.e., energy spectrum and intensity of each of the components, one can then proceed with some confidence to the use of detectors whose response is ambiguous (rad or rem meters), but which may be of practical use. Shielding for personnel and equipment can be accurately specified, and one can predict the effect of changes in operating conditions of the accelerator. This analytic approach to very-high-energy radiation monitoring requires time and effort, but these are repaid by the accuracy, flexibility, and understanding achieved. Author (NSA)

N67-38432 European Organization for Nuclear Research, Geneva (Switzerland).
ON DETERMINATION OF SPIN, DECAY PARAMETERS, AND DENSITY MATRIX OF DECAYING STATES
N. Byers 18 Aug. 1967 50 p refs
(CERN-67-20)

A Lorentz invariant angular correlation function F is defined for the equation X→A+K with A→p+π, where X represents a particle with spin J, K represents particles with spins one-half and zero, and the decay A→p+π serves to measure the polarization of A. The definition is given for X produced in reactions with two and three body final states. The dependence of F on J, α, β, γ, and the multipole parameters is displayed. The discussion of spin multipole parameters relates them directly to the density matrix, gives their symmetry properties, and expresses them in terms of the S matrix for production of X. Specific properties of the density matrix of X when produced in a reaction with a polarized target are discussed. Contaminations of F from non-resonant background and/or interactions between decay particles of X and others in the final state, when X is a resonant state, are mentioned. R.N.A.

N67-38453# Ceskoslovenske Akademie Ved, Rez. Ustav Jaderneho Vyzkumu.
TIME-OF-FLIGHT EFFECT OF NEUTRONS ON DECAY CONSTANT IN THE DIFFUSION MEASUREMENTS BY PULSE METHOD [VLIV DOBY LETU NEUTRONU NA "ROZPADOVOU" KONSTANTU PRI MERENI DIFUSNICH KONSTANT IMPULSNI METODOU]

J. Cervena, R. Bayer, and W. Schaeferlingova Feb. 1967 47 p refs In CZECHOSLOVAKIAN; ENGLISH summary
(UJV-1720)

An analysis of the time-of-flight effect of neutrons escaping from a moderator on the measured decay constant α in neutron pulse experiments is given. It is shown that this effect depends on the detector distance from the moderator and on the geometric buckling β^2 and that it substantially modifies measured values of the decay constant. The deviation of α is different for different types of moderators, other circumstances unchanged, and represents 22% for light water and 32% for solid diphenyl at the detector to moderator distance of 11.75 cm and $\beta^2 = 0.80$ cm^{-2}. From these results the conclusion is drawn that in pulse experiments with far-off detectors either the range of bucklings used must be reduced and/or due corrections to measured α values must be introduced. Author (NSA)

N67-38457# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
STUDY OF THE η MESON PRODUCTION AND DECAY IN π^+d INTERACTIONS BETWEEN 600 AND 900 MeV [ETUDE DE LA PRODUCTION ET DE LA DESINTEGRATION DU MESON η DANS LES INTERACTIONS π^+-DEUTERIUM ENTRE 600 ET 900 MeV]
Eugene Pauli (Ph.D. Thesis—Strasbourg Univ., 15 Dec. 1965) 1967 69 p refs In FRENCH
(CEA-R-3105)

The reaction $\pi^+ + d \rightarrow p + p + \eta$ is observed in the 35 cm and 50 cm deuterium bubble chambers. A total of 150,000 pictures was taken at six incident energies of the π^+ between 600 and 900 MeV in a π^+ separated beam. The results of this study show that the η production cross section increases rapidly at threshold, then decreases slowly at higher energies. The η production angular distribution in the π^+-neutron cms is isotropic. From both of these facts, it is concluded that the η is produced in a S wave near threshold. As for the η decay, the values of the following branching ratios were determined: $\Gamma_\eta(\gamma\gamma)/\Gamma_\eta(\pi^0\pi^0\pi^0) = 1.1 \pm 0.5$. Author (NSA)

N67-38458# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Reactions.
ON THE POSSIBILITY OF USING THE AUGER-NEUTRALIZATION FOR MULTIPLE CHARGED IONS IDENTIFICATION [O VOZMOZHNOSTI ISPOL'ZOVANIYA OZHENEITRALIZATSII DLYA IDENTIFIKATSII MNOGOZARYADNYKH IONOV]
E. S. Parilis 1967 11 p refs In RUSSIAN; ENGLISH summary
(JINR-P7-3355)

An evaluation of the Auger-electron emission when a multiply charged ion approaches a metal surface shows that it is possible in principle to use this phenomenon for identification of the multiply charged ions on the background of singly charged ones. In the synthesis of transuranium elements accelerators of heavy multiply charged ions are used. When analyzing an ion beam with the help of a mass analyzer with low resolving power separation by e/m takes place and the pairs of singly and multiply charged ions corresponding to equal or near values of this ratio (Kr^{+7}_{84} and C^{+1}_{12}, Kr^{+10}_{84} and O^{+1}_{16}, Xe^{+10}_{131} and C^{+1}_{13}, Xe^{+9}_{131} and N^{+1}_{14}, U^{+13}_{238} and O^{+1}_{16} etc.) find themselves in one beam. There arises the problem of their discrimination by charges. According to theoretical calculations for some pairs the difference in electron emission under two ions forming the pair is very great. It should be noted that these values are quite approximate and must be taken only by their order of magnitude. Author (NSA)

N67-38459# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
THE BOGOLIUBOV DISTRIBUTIONS AND THE CAUSAL S-MATRIX ELEMENTS [OBOBSHCHENNYE FUNKTSII BOGOLYUBOVA I ELEMENTY PRICHINNOI S-MATRITSY]
L. Sh. Khodzhaev 1967 17 p refs In RUSSIAN
(JINR-P05-3180)

A class of the Bogoliubov distributions is introduced and a number of their important properties is found. The causal S-matrix elements are expressed in terms of the Bogoliubov distributions. Author (NSA)

N67-38503# Rome Univ. (Italy). Istituto di Fisica.
CONDENSATION OF REGGE CUTS, VANISHING TOTAL CROSS-SECTIONS AND TWISTING TRAJECTORIES
Yogendra Srivastava 5 May 1967 6 p refs Supported in part by the NSF /ts Note No. 120
(NP-16870)

It is conjectured that the simplest way to avoid the $J = \alpha(0)$ problem (condensation of infinite Regge cuts there) is to have the Pomeranchuk intercept slightly less than one. Thus cross sections would asymptotically tend to zero. Experimental evidence in this regard is quite unclear. However, with hypothesis, the leading singularity generated by the parent Regge pole in collusion with the Pomeranchuk pole (which is assumed straight) is constantly changing its curvature (twist effect). Some evidence in support of a twisted leading singularity is presented. NSA

N67-38505# Illinois Univ., Urbana. Dept. of Physics.
LEMA: A PROGRAM FOR CALCULATING NEUTRON CROSS SECTIONS WITH THE R-MATRIX FORMALISM AND WITH THE COMPLEX POLE EXPANSION OF THE COLLISION MATRIX
D. B. Adler and F. T. Adler Mar. 1967 106 p refs
(Contract AT(11-1)-1546)
(COO-1546-4) CFSTI: HC $3.00/MF $0.65

The program LEMA calculates neutron cross sections in fissionable elements with the alternate approaches of the Wigner level matrix and of the generalized Kapur–Peierls expansion using the complex poles of the collision matrix. The calculation proceeds from a given set of R-matrix parameters, and the complex eigenvalues of the level matrix are hence derived. Two alternate evaluations of the cross section curves are provided, and parameters for the multilevel expansion are produced. Two FORTRAN II versions of LEMA and a preliminary FORTRAN IV version are given. As an illustration of the potential uses of these programs, preliminary results of calculations of interference effects in closely spaced resonances are presented. Author (NSA)

N67-38525# Michigan Univ., Ann Arbor.
PION-NUCLEON ELASTIC SCATTERING IN THE BACKWARD HEMISPHERE AND THE APPLICATION OF REGGE THEORY TO BACKWARD ANGLES OTHER THAN $\cos\theta = -1$
Fikri Ned Dikmen (Ph.D. Thesis) 1966 80 p refs
(Contract AT(11-1)-1112)
(COO-1112-107) CFSTI: HC $3.00/MF $0.65

The features and structure of the angular distributions in the meson (π)–nucleon elastic scattering process at 2.3 to 4.0 GeV/c for incoming mesons (π^+) and at 2.5 to 6.0 GeV/c for incoming mesons (π^-) are investigated. The secondary maximum, the backward peak, and the variation in their structure as a function of energy are studied. The results of Regge theory applied to backward scattering are also presented. NSA

N67-38526# Michigan Univ., Ann Arbor.
THE SECONDARY MAXIMUM IN PION–PROTON ELASTIC SCATTERING FROM 2.5 GeV/c TO 6.0 GeV/c
Lester Andrew Ettlinger (Ph.D. Thesis) 1966 62 p refs
(Contract AT(11-1)-1112)
(COO-1112-108) CFSTI: HC $3.00/MF $0.65

The differential cross section for elastic scattering of pions by protons between 2.5 and 6.0 GeV/c was measured in a spark chamber experiment at the Argonne ZGS. There is a secondary

maximum in the differential cross section in the region $.6 < |t| < 2.8$ $(GeV/c)^2$, which decreases smoothly as a function of increasing beam momentum. For a given momentum of the incident pion, the scattering cross sections for π^+p and π^-p at the peak of the second maximum are equal, within statistical errors, in all cases. The pion–nucleon charge exchange cross section is seen to exhibit a secondary maximum at approximately the same value of t and is compared with the elastic scattering distributions. The effect of N^* resonances on the elastic scattering distributions is discussed. Author (NSA)

N67-38527# Michigan Univ., Ann Arbor.
EXPERIMENTS ON CHARGED QUANTIZED VORTEX RINGS IN He(II)
George Gamota (Ph.D. Thesis) 1966 142 p refs
(Contract AT(11-1)-1112)
(COO-1112-113) CFSTI: HC $3.00/MF $0.65

Results of two experiments on charged quantized vortex rings in superfluid He are reported: a direct measurement of the size of the rings as a function of their energy, and a study of the interactions of oppositely charged beams of quantized vortex rings at various temperatures. The size measurement supported the hypothesis that classical equations can be applied to the behavior of quantized microscopic entities. Preliminary results of the interaction experiment at low temperatures indicated that the vortex–vortex interaction cross section is proportional to the geometrical area and is approximately one order of magnitude larger. At higher temperatures, a threshold temperature was found, which can be interpreted to mark a switchover from the vortex ring to the free-ion domain. Two theoretical problems pertaining to the experiments are considered: an axially symmetric approach of a vortex ring to an aperture in the wall, and the interaction of paired vortex lines. NSA

N67-38528# Michigan Univ., Ann Arbor.
DIFFERENCES BETWEEN π^+p AND π^-p ELASTIC SCATTERING IN THE DIFFRACTION PEAK REGION
Alfred Saulys (Ph.D. Thesis) 1966 52 p refs
(Contract AT(11-1)-1112)
(COO-1112-103) CFSTI: HC $3.00/MF $0.65

An experiment is described in which the elastic differential cross sections were measured for π^+p scattering at π incident momenta of 2.3 to 4.0 GeV/c and for π^-p scattering at 2.5 to 8.0 GeV/c. The experimental procedure in obtaining the data, the method of analysis, and the observed differences between π^+p and π^-p elastic differential cross sections are discussed. NSA

N67-38529# Michigan Univ., Ann Arbor.
A HIGH-RESOLUTION MEASUREMENT OF THE HYPERFINE STRUCTURE OF THE J=1 ROTATIONAL STATE OF ^{133}Cs–^{19}F BY THE MOLECULAR-BEAM ELECTRIC-RESONANCE METHOD
Thomas Crandall English (Ph.D. Thesis) 1966 278 p refs
(Contract AT(11-1)-1112)
(COO-1112-112) CFSTI: HC $3.00/MF $0.65

The measurement and analysis of the radio-frequency spectrum of cesium fluoride, and the design, construction, and operational characteristics of the high-resolution, very-weak-field molecular-beam electric-resonance spectrometer with which this measurement was made are reported. This measurement is part of a long range program to study electric and magnetic hyperfine interactions in polar diatomic molecules. NSA

N67-38540# Yale Univ., New Haven, Conn. Dept. of Physics.
VELOCITY DISTRIBUTION OF METASTABLE H ATOMS PRODUCED BY DISSOCIATIVE EXCITATION OF H_2
M. Leventhal, R. T. Robiscoe, and K. R. Lea (1967) 37 p refs
(Contract AT(11-1)-1112)
(COO-1112-120) CFSTI: HC $3.00/MF $0.65

The velocity spectrum of metastable H(2S) atoms produced by electron bombardment of H_2 has been measured by a time-of-flight technique. Two distinct groups of metastables have been detected. The slower atoms are interpreted as arising from transitions to attractive states just above the H(1S) + H(2S) dissociation limit. The faster atoms are thought to arise from transitions to doubly excited repulsive states not previously detected. The same technique was used to obtain similar data for deuterium. Author (NSA)

N67-38541# Brown Univ., Providence, R. I. Dept. of Physics.
A RESEARCH PROGRAM IN EXPERIMENTAL HIGH-ENERGY PHYSICS
Anatole M. Shapiro 1 Jun. 1967 14 p refs
(Contract AT(30-1)-2262)
(NYO-2262TB-131) CFSTI: HC $3.00/MF $0.65

A review of the experimental program of the Department of Physics at Brown University during September 1, 1966–August 31, 1967 includes the AGS spark chamber experiment, the $\bar{p}$–p bubble chamber experiment, the Cosmotron spark chamber experiment, the Argonne bubble chamber experiment, the backward scattering AGS spark chamber experiment, the PDP-9 computer interface, geometric reconstruction computer programs, and Argonne beam designs. NSA

N67-38542# Columbia Univ., Irvington, N. Y. Dept. of Physics.
EXPERIMENTAL STUDY OF THE DECAY $K^+ \rightarrow \pi^0 e^+ \nu$
Robert W. Garland (Ph.D. Thesis) 1967 118 p refs
(Contract AT(30-1)-1932)
(CU-1932-285; NEVIS-161) CFSTI: HC $3.00/MF $0.65

An experiment was performed using a magnet and spark chambers to study the decay $K^+ \rightarrow \pi^0 e^+ \nu$. Electrons were recognized by their shower production in 1/4-in. aluminum plate spark chambers. On the basis of a spectrum of about 300 observed Ke3 events, it was concluded that the coupling form in the decay interaction is vector. The value found for the Ke3 branching ratio, R Ke3 = 0.045 ± 0.004, agrees with the prediction of the $\Delta I = 1/2$ rule and K%3 data, and when combined with the $K_{\mu 3}$ branching ratio, also measured in this experiment, yields a value for the parameter $\Xi = f_-/f^+$: $\Xi = 1.3 \pm 0.5$. Author (NSA)

N67-38545# Rome Univ. (Italy). Istituto di Fisica.
APPROACH TO THE PROBLEM OF SCATTERING ON SINGULAR MULTICHANNEL POTENTIALS
C. Marchioro 12 Jul. 1966 9 p refs *Its* Note No. 104
(NP-16844)

An iterative method for the evaluation of the partial wave scattering amplitude produced by a spherically symmetrical multichannel potential is presented. Author (NSA)

N67-38547# International Centre for Theoretical Physics, Trieste (Italy).
INELASTIC N/D EQUATIONS AND REGGE THEORY
R. L. Warnock Jul. 1967 52 p refs
(IC-67/55)

The practical and theoretical aspects of N/D equations are considered. The discussion covers physical values of the angular momentum in the direct channel, but with account taken of Regge asymptotic behavior in the limit of infinite direct channel energy. The inelastic N/D equation is derived, and a generalized form of the Levinson theorem is proved. The behavior of partial waves at infinity in Regge theory is considered, and the Fredholm character of the N/D equations in Regge theory is demonstrated. Also a tentative proposal for dynamical calculations with Regge trajectory exchange is described. NSA

N67-38548# Rome Univ. (Italy). Istituto di Fisica.
SUPERCONVERGENT PHASE-SHIFT, ASYMPTOTIC REGGE RESIDUA AND ELASTIC-WIDTH VS. MASS RELATIONS
Yogendra Srivastava 20 May 1967 8 p refs Supported in part by NSF *its* Note No. 123
(NP-16882)

Under fairly general assumptions, a superconvergent relation for the phase-shift (spin or no spin) is written down purely in terms of its Regge singularities. Using them directly at the resonance energies, yields a simple relation between the elastic width and the mass of a resonance. As a by-product, Khuri's (assumed) bound on the residue function, $|\beta(s)| \leq s^{-1/2}$ is shown to be essentially saturated. The results are in quantitative agreement where data are available. Author (NSA)

N67-38556# Illinois Univ., Urbana. Dept. of Physics.
TANDEM: A PROGRAM FOR THE TWO-FOLD LEAST-SQUARES ANALYSIS OF CAPTURE AND FISSION CROSS SECTIONS WITH THE MULTILEVEL EXPANSION
D. B. Adler Mar. 1967 63 p refs
(Contract AT(11-1)-1546)
(COO-1546-5; TR-5) CFSTI: HC$3.00/MF$0.65

The program TANDEM was developed for the simultaneous fitting of capture and fission cross sections in the fissile elements, using the multilevel expansion. The version presented is written in FORTRAN II and is operable on the IBM 7094 of the University of Illinois. This program consists of a combination of subroutines which at a later stage could be utilized to include the fitting of transmission data. This generalization of the program could be best accomplished using a larger computer such as an IBM 360 system. Nonlinear iterations on the values of the resonance energies and half-widths are executed by the program subject to flexible numerical tests and constraints which are introduced to enhance the convergence of the fitting process. The present formulation of the constraints attempts to utilize both the physical properties of the parameters which are involved in the fitting process, and the numerical experience gained with the preliminary use of the code. Author (NSA)

N67-38557# Brookhaven National Lab., Upton, N. Y.
ELECTROMAGNETIC LIFETIMES
E. K. Warburton [1967] 40 p refs Presented at the Symp. on Nucl. Phys. Res. with Low-Energy Accelerators, College Park, Md., 19 Jun. 1967
(BNL-11484; CONF-670615-1) CFSTI: HC$3.00/MF$0.65

A review is given of techniques used to measure electromagnetic lifetimes of nuclear levels in light- and medium-weight nuclei which can be accomplished using small (energy ≤4 MeV) accelerators. The methods discussed are electronic timing (pulsed-beam techniques, delayed coincidences, etc.); recoil distance; Doppler-shift attenuation (including Doppler-shape measurements); and capture cross section methods. A number of experimental examples are given. NSA

N67-38558# Kernforschungszentrum, Karlsruhe (West Germany). Zyklotron--Laboratorium.
MEASUREMENT OF THE DECAY OF ^{200}Bi AND ^{202}Bi [MESSUNGEN AM ZERFALL DES ^{200}Bi UND ^{202}Bi]
A. Hanser and K. Freitag Feb. 1967 22 p refs In GERMAN; ENGLISH summary
(KFK-541)

From the decay of ^{200}Bi and ^{202}Bi, γ-spectra, conversion-electron spectra, γ–γ coincidences, γ–e coincidences, and conversion coefficients were measured using mass-separated samples. Four excited levels of ^{200}Pb were found. Probable spin-parity assignments are given. The level scheme of ^{202}Pb known from investigations on ^{202m}Pb was confirmed. Lower limits for the very high decay energies of both nuclei are given, and the relatively small overall position emission rates were measured. Author (NSA)

N67-38569# California Univ., Berkeley. Lawrence Radiation Lab.
K^+n CHARGE EXCHANGE AND THE ρ' REGGE TRAJECTORY
Bertram M. Schwarzschild (Ph.D. Thesis) 8 Jun. 1967 43 p refs
(Contract W-7405-ENG-48)
(UCRL-17572) CFSTI: HC$3.00/MF$0.65

Finding that the Regge exchange of ρ and A_2 fails to describe the K^+n charge-exchange data at 2.3 GeV/c (the highest energy available to date) when a simultaneous fit is attempted with higher energy data on K^-p and π^-p charge exchange and $\pi^-p \to \eta^0 n$, a second, lower lying ρ-type trajectory (ρ') is introduced. This also provides a possible mechanism for the puzzling π^-p charge-exchange polarization. It is found that one is then able simultaneously to fit all these data (including the polarization), together with related total cross section differences up to 20 GeV/c, with a ρ' whose spin-1 mass is 1.0 GeV [perhaps the $\delta(965)$?] and whose t=0 intercept, 1.1 units of angular momentum below the ρ, agrees roughly with the ρ' proposed by Högaasen and Fischer to describe forward pp and np charge exchange, where the (ρ,A_2) model also fails. The ρ and A_2 trajectories turn out to be essentially traditional. In the fit only small SU_3 breaking between the KK and $\pi\pi$ (or $\eta^0\pi$) couplings to the trajectories is permitted. The fit is further constrained to obey the sum rule of Igi and Matsuda. In fitting the K^+ data at 2.3 GeV/c, a deuteron correction is included, and exact Legendre functions rather than the high-energy asymptotic Regge forms are employed. Predictions for higher energy K^+ charge exchange are offered. Author (NSA)

N67-38572# General Dynamics Corp., San Diego, Calif.
GAF: A COMPUTER PROGRAM FOR CALCULATION OF NEUTRON SPECTRA AND AVERAGE CROSS SECTIONS IN THE HIGH ENERGY REGION
D. R. Mathews and R. J. Archibald 20 Jan. 1967 75 p refs
(Contract AT(04-3)-167)
(GA-7169) CFSTI: HC$3.00/MF$0.65

A computer program, GAF, was written to compute neutron fluxes and currents from the B_1 equations for a maximum of 1740 energy groups above the thermal energy region. The calculated fluxes may be used to prepare average cross sections for up to 99 broad energy groups. Special data handling techniques are used to allow the practical utilization of such a large number of energy groups. The program is written in the FORTRAN-IV language for the UNIVAC-1108 computer. Author (NSA)

N67-38578# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE EVALUATION OF THE HEIGHT OF EFFECTIVE MUON PRODUCTION LEVEL IN EAS BY MEANS OF ATTENUATION MEASUREMENTS [OCENA EFEKTYWNEJ WYSOKOŚCI POZIOMU PRODUKCJI MIONÓW W WIELKICH PEKACH PRZY UŻYCIU METODY POMIARU ATENUACJI]
R. Firkowski, J. Wdowczyk, and A. Zawadzki 1967 14 p In ENGLISH and POLISH
(INR-803/VI/PH)

The upper limit of the muon effective production height is evaluated by measurement of the barometric effect of the EAS muonic component and on the basis of the determination of the muon density spectrum exponent γ_μ. Both values were obtained using a recording of about 140,000 showers of the mean size of about 2×10^6. The following results were obtained: for the EAS muon barometric effect, $\beta_\mu = (5.2 \pm 0.7)$ % per 1 cm Hg; for the mean free path of muon absorption, $\lambda = 690$ g/cm^2; and $\gamma_\mu = 2.09 \pm 0.02$. Analysis of the data obtained indicates that the upper limit of the effective production level is $h_\mu = (10 \pm 3)$ km. Author (NSA)

N67-38688# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
THE FLUCTUATIONS IN THE LONGITUDINAL AND LATERAL DEVELOPMENT OF E.A.S. AND THEIR INFLUENCE UPON THE SPECTRUM OF THE RATIO OF THE MUON TO ELECTRON COMPONENT DENSITY [FLUKTUACJE W ROZWOJU PODLUZNYM I PODLUZNYM WIELKICH PEKOW ORAZ WPLYW NA ROZKLAD STOSUNKOW GESTOSCI SKLADOWEJ MIONOWEJ DO ELEKTRONOWEJ]
J. Gawin, J. Hibner, R. Maze, J. Wdowczyk, and A. Zawadzki 1967 18 p refs In ENGLISH and POLISH
(INR-804/VI/PH)

The fluctuations of the μ component due to the longitudinal and lateral development of the EAS were found experimentally in an indirect way. The value of their standard deviation, $\sigma = 0.34 \pm 0.05$, seems to be in a good agreement with a calculated theoretical one ($\sigma = 0.30$). The apparently small value of σ can be satisfactorily explained on the basis of a strong negative correlation between the mean muonic radius r_μ and the EAS size N_e at constant total energy E_0. This negative correlation is suggested in the quoted theoretical work. It leads to a positive correlation between Δ_μ and Δ_e when measured in the central part of a shower of constant size. The decreasing of the $\sigma(\Delta_\mu/\Delta_e)$ as compared to the $\sigma(\Delta_\mu/\Delta_e) \approx 0.51$ results from the compensation due to the mentioned positive $\Delta_\mu - \Delta_e$ correlation. Author (NSA)

N67-38618# Polish Academy of Sciences, Warsaw. Inst. of Nuclear Research.
ANALYSIS OF AZIMUTHAL ANGULAR DISTRIBUTIONS OF SECONDARIES FROM INTERACTIONS OF COSMIC RAY PARTICLES WITH EMULSION NUCLEI [ANALIZA ROZKLADOWKATOW AZYMUTALNYCH CZASTEK WTORNYCH Z ODDZIALYWAN PROMIENIOWANIA KOSMICZ ZJADRAMI EMULSJI JADROWEJ]
Z Czechowska, A. Jurak, and A. Linscheid 1967 16 p refs
(INR-788/VI/PH)

Azimuthal angular distributions of 65 events of interactions of cosmic particles with emulsion nuclei have been studied from the viewpoint of noncolinear emission of fireballs. Significant deviation from isotropic distribution of azimuthal angles has been found in the group of events with $\gamma_c \leq 20$ (where γ_c is the Castagnolli estimate of the Lorentz factor of the cms). No such deviation was found for events with $\gamma_c > 20$. Author (NSA)

N67-38619# Gosudarstvennyi Komitet Po Ispolzovaniyu Atomnoi Energii, Obninsk (USSR). Fiziko-Energeticheskii Inst.
ANGULAR ANISOTROPY AND THE EFFECT OF NUCLEON PAIR CORRELATION DURING THE FISSION OF NUCLEI BY NEUTRONS [UGLOVAYA ANIZOTROPIYA I EFFEKTY PARNOI KORRELYATSII NUKLONOV PRI DELENII YADER NEITRONAMI]
G. N. Smirenkin, V. G. Nesterov, and A. S. Tishin 1966 30 p refs In RUSSIAN
(FEI-67)

The energy dependence of the angular anisotropy of the fission of ^{233}U, ^{235}U, and ^{239}Pu with neutrons and of ^{233}U with α particles was discussed. In conformance with the statistical theory of the angular distribution of the fragments, the dependence of the mean square of the projection of the moment of the compound nucleus on the fission axis K^2 on the excitation energy E at the saddle point was obtained. The analysis of the dependence $K^2(E)$ made it possible to determine for ^{240}Pu at the deformed surface the state of the critical energy as $E_{cr} = 9.5 \pm 3$ MeV from which originated the transition from the superfluid phase to the normal and the size of the energy gap in the spectrum of the internal excitation as $2\Delta_0 = 1.8 \pm 0.3$ MeV. The values obtained were significantly lower than the last data on these magnitudes. It was shown that the rate of regression to the Fermi gas model was dependent on the effects of the correlation of the nucleons and was significantly lower than was assumed earlier. Author

N67-38620# Comitato Nazionale per l Energia Nucleare, Frascati (Italy).
REAL PHOTON APPROXIMATION FOR ELECTRO MAGNETIC PROCESSES ON LIGHT NUCLEI
A. Malecki 20 Jul. 1967 16 p refs *Its* Nota Interna No. 374
(LNF-67151) CFSTI: HC $3.00/MF $0.65

The electrodynamic processes on light nuclei are considered and related to the nuclear photoabsorption and to the gamma emission processes. In particular, the Weizsäcker–Williams approximation is analyzed. The general inelastic sum rule, correct through order $1/M^2$ (M—nucleon mass) with the corrections due to subtraction of the c.m. motion, is derived. High energy electron scattering and electron pair photoproduction are discussed as examples. Author

N67-38630# Rome Univ. (Italy). Istituto di Fisica.
FINITENESS OF RADIATIVE CORRECTIONS TO π β-DECAY
N. Cabibbo, L. Maiani, and G. Preparata 29 May 1967 8 p refs *Its* Note No. 124
(NP-16868)

In order to determine the finiteness of radiative corrections to $\pi^- \to \pi^0 + e\bar{\nu}$ the graph where the $e\bar{\nu}$ pair is emitted through the axial part of the hadronic weak current is considered. This contribution is added to the matrix element for the π^- decay discussed. A sum rule is found which ensures that cancellation in a particular case would be universal, and the radiative corrections would then turn out to be finite in the physical π^- beta decay as well as in any other vector beta decay. NSA

N67-38631# Rome Univ. (Italy). Istituto di Fisica.
ASYMPTOTIC UNITARITY CONSTRAINTS ON REGGE MULTIPOLES AND CUTS
Yogendra Srivastava 10 May 1967 7 p refs Supported in part by NSF *Its* Note No. 122
(NP-16869)

Some constraints implied by the asymptotic unitarity condition on the possible forms of Regge singularities are discussed. Under certain assumptions, it is found that a Regge (simple) pole is insufficient. Author (NSA)

N67-38641# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).
STUDY OF THE RECOMBINATION IN HEXANE IONIZATION CHAMBERS IRRADIATED WITH GAMMA RAYS
A. Giovs, M. Ledu, and M. Pelliccioni 21 Jun. 1967 13 p refs Submitted for publication *Its* Nota Interna No. 368
(LNF-67/42) CFSTI: HC $3.00/MF $0.65

After a theoretical investigation of the influence of columnar and general recombination on the conductivity on n-hexane irradiated with γ-rays from Co^{60}, the authors described the measurements carried out with a view to confirming the theory, with the changing of chamber geometry, of the applied electric field and the dose rate. The experimental data are in good agreement with theoretical predictions, at least within the limits of the experiment described. Finally, a discussion is made of the importance of the results obtained with a view to developing the application in dosimetry of liquid-dielectric ionization chamber. Author

N67-38642 Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.
ON THE MASS TERM OF SUB-HADRONIC SYSTEMS
Ziro Maki and Isao Umemura Aug. 1967 17 p refs
(RIFP-64)

The mass term in a simple Lagrangian model for the sub-hadronic fields (urbaryons or quarks) is studied. In the case of chiral-type interactions the bare particle mass m_0 of them is estimated to be strikingly small under two essentially different ways of approximations. The nonrelativistic treatment leads to $m_0\mu$(the pion mass)/2 in the static limit. On the other hand, the soft pion limit with the use of commutator saturation approximation, which seems to be reasonable in the spirit of PCAC relation, yields a result $m_0 \approx \mu/2\sqrt{2}$. Physical implications of these results are also discussed. Author

N67-38643 Cekmece Nuclear Research Center, Istanbul (Turkey).
PARAMETERS FOR THE FIRST NEUTRON RESONANCE IN CD 113
R. O. Akyuz, C. Cansoy, and F. Domanic Dec. 1965 20 p refs
(CNAEM-34)

The total neutron cross section of Cd^{113} has been measured in the energy range from 0.025 eV to 1 eV with a crystal spectrometer using the Be(1011) and NaCl(200) crystal planes as monochromators. A new method for second order correction was applied, and the resonance at 0.181 eV was fitted to a Breit–Wigner single-level formula by the method of least squares. The resonance parameters obtained from the analysis are given. Author

N67-38644# Bettis Atomic Power Lab., Pittsburgh, Pa.
MEASUREMENT OF THE EFFECTIVE RESONANCE INTEGRAL OF 30-MIL THORIUM WIRE RELATIVE TO THE INTEGRAL AT INFINITE DILUTION
A. B. Rothman, J. C. Connor, and D. E. Conway Mar. 1967 15 p refs
(Contract AT(11-1)-GEN-14)
(WAPD-TM-622) CFSTI: HC $3.00/MF $0.65

The effective neutron–capture resonance integral I of 30-mil-diameter thorium wire (surface-to-mass ratio, S/M, of 4.65 cm^2/g) was measured relative to I_0, the integral at infinite dilution, by comparing the ratio of the gamma activities induced in wires irradiated bare and under cadmium with a similar ratio measured for very dilute thorium foils. The experimental results for I/I_0 is 0.425 ± 0.005 for an infinite–length wire in a 1/E spectrum relative to a low-energy cutoff of 0.5 eV. This result and the values reported by other investigators for heavily self-shielded and dilute thorium are least squares fitted by an expansion in powers of the square root of S/M. Author (NSA)

N67-38650# California Univ., Berkeley. Lawrence Radiation Lab.
NUCLEAR SPIN AND HYPERFINE STRUCTURE MEASUREMENTS ON THE RADIOACTIVE ISOTOPES ^{110}In, ^{121}Sn, AND ^{88}Rb
Michael Herbert Prior (Ph.D. Thesis) 25 Mar. 1967 96 p refs
(Contract W-7405-ENG-48)
(UCRL-17472) CFSTI: HC $3.00/MF $0.65

The atomic-beam magnetic-resonance technique was used to measure the nuclear spin of 66-min ^{110}In, the spin and hyperfine structure interaction constants a and b for 27-hr ^{121}Sn in the $^3P_1$ electronic state, and the a constant for 18-min ^{88}Rb(I = 2). Values of the nuclear moments are inferred from the measured interaction constants. The χ^2 of the least-squares computer fit to the observations is listed for the two possible signs of the interaction constants. The figures in parentheses represent the error in the last figure quoted. For the hfs constants this is one standard deviation from the computer mean. For μ_I the error is 1% to allow for effects of a possible hyperfine structure anomaly. For Q the error is 50% to allow for inaccuracies in the calculation of $\langle r^{-3} \rangle$ and the effects of Sternheimer shielding. A relativistic calculation accounts for $\approx 1/3$ of the a for ^{121}Sn, and the remainder is attributed to the effects of configuration interaction. Second-order corrections to the hfs constants are shown to be negligible for ^{121}Sn. The nuclear quantities, except for Q, are in reasonable agreement with values calculated by using the shell model with an appropriate residual interaction, provided one takes the negative sign for the interaction constants. The quadrupole moment of ^{121}Sn may arise from polarization of the proton core. Author (NSA)

N67-38657# Los Alamos Scientific Lab., N. Mex.
HYDRODYNAMIC CALCULATION OF EFFECTIVE MASSES OF BINARY NUCLEAR FISSION
Rainer W. Hasse [1965] 56 p refs
(LA-tr-67-15) CFSTI: HC $3.00/MF $0.65

The kinetic energy of the asymmetric and symmetric fission process is calculated for the possible intermediate configuration up to the breaking point of the nucleus without the Wheeler condition. It is assumed that a surface deformation produces hydrodynamically ideal flow of the incompressible nuclear material. NSA

N67-38661# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.
S-MATRIX IN TWO-DIMENSIONAL MODEL OF BORN-INFELD FIELD [S-MATRITSA V DVUKHMERNOI MODELI POLYA BORNA-INFEL'DA]
B. M. Barbashov 1967 22 p refs In RUSSIAN Submitted for publication
(JINR-P2-3330)

The S-matrix is built on the basis of the asymptotic solutions of nonlinear equation describing the Born–Infeld scalar field in the two-dimensional space (x,t). The difference is discussed between the approaches based on the Heisenberg motion equations and that on the interaction representation. Only the first approximation gives a correct result when finding the S-matrix by means of the perturbation theory. The found S-matrix leads to the particle scattering process which is reduced to the change of the plane wave phase proportionally to the colliding particle moments. Author (NSA)

N67-38670# Minnesota Univ., Minneapolis.
PHOTO-EJECTION OF ELECTRONS FROM BUBBLE STATES IN LIQUID HELIUM (II)
Jan Arwood Northby (Ph.D. Thesis) Dec. 1966 158 p refs
(Contract AT(11-1)-1112)
(COO-1112-114) CFSTI: HC $3.00/MF $0.65

Observation of the photoejection of electrons trapped in bubble states in liquid helium is reported. Detection of this effect offers very direct evidence of the validity of the bubble model. An electron which spends part of the time untrapped should have a higher average drift velocity in an electric field than one which remains in a bubble. A time-of-flight apparatus was used to detect changes in the drift velocity of electrons when they are exposed to radiation in the one-micron region. An effective cross section was measured as a function of light wavelength. The experimental curves are compared with cross sections calculated for spherical square wells of various depths and radii. If the current experimental value of the well depth is used agreement is obtained with theory if the bubble radius is either 14.90 ± 0.30 Å, or 20.55 ± 0.35 Å. These results are in reasonable agreement with previous theoretical and experimental estimates. The observed magnitude of the effect is also consistent with theory. Author (NSA)

N67-38672# Georgia Inst. of Tech., Atlanta.
STUDIES OF THE M/L ORBITAL ELECTRON CAPTURE RATIO IN ^{37}Ar DECAY
Jean-Paul A. Renier (M.S. Thesis) Jun. 1967 63 p refs
(Contract AT(40-1)-3346)
(ORO-3346-10) CFSTI: HC $3.00/MF $0.65

Recent investigations of the pulse height distribution from proportional counters due to single- and multiple-electron events

make it possible to measure single electron spectra down to essentially zero energy with much greater accuracy than heretofore. The ratio of M- to L-orbital electron capture in the decay of 35-day ^{37}Ar was measured in a single-wire proportional counter containing the gaseous source. This counter was operated with variable paralysis times, 3.8 msec being used in the experiments to minimize the contribution from negative ions. The experiment was undertaken because of the considerable disagreement between experimental and theoretical M/L capture ratios, particularly in the region of low Z. A survey of all experimental work on M-capture is included for comparison with available theoretical results. NSA

N67-38673# Princeton Univ., N. J. Palmer Physical Lab.
CORE POLARIZATION EFFECTS IN MASS 15 AND MASS 17
Agam Prakash Shukla (Ph.D. Thesis) May 1967 148 p refs
(Contract AT(30-1)-937)
(PUC-937-262) CFSTI: HC$3.00/MF$0.65

The effects of residual interaction are investigated in ($^{16}O \pm 1$ nucleon) nuclei. Wave functions of the $1/2^-$ and $3/2^-$ states of ^{15}O and ^{15}N are constructed by mixing the single-hole spherical and (2p–3h) deformed configurations. The even-parity states of mass 15 are constructed by mixing the (1p–2h) and (3p–4h) deformed states. The Nilsson model is used for constructing the intrinsic states; and the physical, deformed states (members of the rotational bands) are obtained by angular momentum projection. The effective charge for the E2 transitions among odd-parity states of mass 15 is calculated by taking account of the contribution of the 2^+ states of the ^{16}O core. An effective quadrupole–quadrupole force is used for the lowest 2^+ states while Hamada–Johnston realistic matrix elements are used to construct the T=0 and T=1 RPA vibrations. The eigenfunctions and eigenvalues thus obtained agree well with the previous calculations and the $^{16}O(\gamma,n)^{15}O$ and $^{16}O(e,e')^{16}O$ scattering data. The (E2/M1) mixing ratio of the ($3/2^-$ 6 MeV $\rightarrow$ $1/2^-$ g.s.) transition in mass 15 is calculated. The phase of the calculated values agrees with experiment. The magnitude of x(E2/M1)^{15}O is in good agreement with experiment while the agreement for x(E2/M1)^{15}N is fair. It is found that 75% of the E2 amplitude of ^{15}O is due to the effective charge. In ^{15}N, the importance of the effective charge is not as large (≈50% of the E2 amplitude). The ($3/2^-$ 6 MeV $\rightarrow$ $1/2^-$ g.s.) transition is found to be predominantly single hole M1 both in ^{15}O and ^{15}N. The electromagnetic decay of the 5-MeV doublet, 5.79-MeV $3/2^+$, 6.29-MeV $3/2^+$, and 6.74-MeV $1/2^+$ states of ^{15}O is also calculated. For the electric transitions, the wave functions are treated as Hill–Wheeler integrals; and a delta-function approximation is used. For the magnetic multipoles M1 and M2, the Nilsson model is used. The transition amplitude is due to odd particle with core effects accounted for by using appropriate gyromagnetic ratios. The partial decay widths, lifetimes, and branching ratios for the above levels are calculated. Agreement with experiment is good. The ft value for the $^{15}O \rightarrow {}^{15}N$ ground state decay is calculated. Comparison with experiment indicates that best agreement is obtained with a 10% deformed admixture in the ground state. The spectroscopic factors of the $1/2^-$ and $3/2^-$ states of mass 15, for single-nucleon pickup reactions $^{16}O(p,d)^{15}O$ etc., are also calculated. Agreement with experiment is again good for 10% deformed admixture. From this, and the calculations of electromagnetic decay of the levels of mass 15, it is concluded that the ground state has a 10% deformed (2p–3h) component. Spectroscopic factors were also calculated for the odd-parity states of ^{17}O in the deuteron stripping reaction $^{16}O(d,p)^{17}O$. It is concluded from this calculation and on the basis of previous work that the low-lying odd-parity states of ^{17}O are predominantly (2p–1h). The calculated spectroscopic factors are in poor agreement with measured values. Therefore, the relevance of the weak coupling model as an alternative to constructing these states, is discussed. Author (NSA)

N67-38690# Pittsburgh Univ., Pa. Dept. of Physics.
MODULATED ATOMIC BEAMS AND THEIR USES
Wade L. Fite *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 191–215 refs (See N67-38681 23-06)

The principal features of modulation techniques as applied to atomic and molecular beam experimentation are first discussed, with particular relation to problems of signal-to-noise ratio. The use of modulation beam techniques in the measurement of collision cross sections in crossed beam experiments is then illustrated by examples of recent work on electron and ion collisions with free atoms, other free radicals and excited atomic and molecular species. Neutral–neutral reactive collisions are also discussed briefly. The application of reflected modulated beam techniques to study the interactions of gases with surfaces is considered, and some recent findings are briefly reviewed. Author

N67-38691# Bonn Univ. (West Germany). Institut fuer Angewandte Physik.
THERMAL ENERGY MOLECULAR BEAM MEASUREMENTS OF ATOM–ATOM DIFFERENTIAL SCATTERING CROSS SECTIONS
Hans Pauly *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 217–235 refs (See N67-38681 23-06)

To obtain information on the intermolecular potential from scattering experiments with molecular beams, it is necessary to first assume some analytical form of the intermolecular potential V(r) such as the Lennard–Jones (n,6) type with a number of adjustable parameters. Observed and calculated differential and total collision cross sections are then compared to determine the parameters of the assumed potential. Most experiments on elastic scattering were carried out at thermal energies, where the scattering cross sections are sensitive primarily to the attractive part of the potential. They included measurements of the long range van der Waals potential, and the distance dependence $V(r)\ r^{-6}$ was demonstrated experimentally from measurements of the differential cross section at small angles as well as from measurements of the velocity dependence of the total elastic cross section. Information obtainable from the glory oscillations in the velocity dependence of the total cross section and interference effects in differential cross sections (rainbow scattering) are discussed in relation to the shape of the intermolecular potential. Author

N67-38692# Bonn Univ. (West Germany). Physikalisches Institut.
THERMAL ENERGY MOLECULAR BEAM MEASUREMENTS OF INELASTIC CROSS-SECTIONS FOR ROTATIONAL QUANTUM TRANSITIONS
J. Peter Toennies *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 237–276 refs (See N67-38681 23-06)

Molecular beam scattering results are reviewed and are compared with theory and with the results of other less direct methods. The relationships between the macroscopic rate experimental methods are summarized. The theory of inelastic scattering and the connection between the intermolecular potential and the inelastic cross sections are briefly discussed. For detecting inelastic scattering two techniques are used. In the one method the inelastically scattered particles are observed by the velocity shift resulting from the loss or gain of kinetic energy. In the other method the change in rotational state of the molecules is directly observed. The experimental techniques and the types of collision processes which are experimentally accessible by both methods are pointed out. The experimental results from the molecular beam experiments and their interpretation are discussed in detail. Recent unpublished measurements of total cross sections are surveyed. Author

N67-38693# California Univ., Los Angeles.
PERFORMANCE OF AN ARC-HEATED SUPERSONIC MOLECULAR BEAM AND ITS APPLICATION TO MOLECULE–MOLECULE COLLISION STUDIES

Eldon L. Knuth and Neil M. Kuluva *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 277–338 refs (See N67-38681 23-06)
(Grants NsG-237-62; NSF-G-9783; NSF GP-534; NSF GK-580)

Bases for designs of the several components of an intermediate-energy high-intensity molecular beam are presented. Intermediate energies and high intensities are realized as a consequence of heating the beam gas in an electric arc and then converting the energy of thermal motion into energy of directed motion in a supersonic jet. Sometimes a two-disk two-slot beam chopper and speed filter is used to chop the beam into bursts, to provide a repetitive signal, to filter out those beam molecules with speeds differing greatly from a selected speed, and to filter out the light emanating from the arc-heated source. Other times a single-disk two-slot beam chopper is used. A through-flow ionization detector, which sees the signal from a chopped beam as an ac signal superimposed upon a dc background, possesses the versatility required. The maximum beam intensity is realized (for the pumping system used presently) at the skimmer orifice flow rate for which the beam is attenuated by a factor of 1/e in the collimating chamber. Molecular energies of the order of 1 eV are measured. Author

N67-38696# Oxford Univ. (England). Dept. of Engineering Science.
THE PRODUCTION OF A 2 eV PULSED ARGON BEAM USING A SHOCK TUBE SOURCE
T. V. Jones *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 377–409 refs Sponsored by Min. of Aviation (See N67-38681 23-06)

Aerodynamic molecular beam methods used to produce a fast beam from a shock tube are discussed. The basis of the method is the continuum expansion of a gas to a high Mach number where the flow density and temperature is such that it becomes free molecular and subsequent collimation of the flow is used to produce a beam. The beam is from a supersonic flow by placing an orifice in the flow such that the orifice diameter was less than the local mean free path. Author

N67-38697# Stichting Voor Fundamenteel Onderzoek der Materie, Amsterdam (Netherlands). Laboratorium Voor Massascheiding.
TOTAL CROSS-SECTION MEASUREMENTS FOR K ON He IN THE ENERGY RANGE OF 0.35 TO 16.5 eV
J. Politiek, J. Los, and J. J. M. Schipper *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 411–422 refs Sponsored by Ned. Organisatie voor Zuiverwetenschap. Onderzoek (See N67-38681 23-06)

A molecular beam apparatus has been constructed, which uses the phenomenon of cathode sputtering for the production of an atom beam. A potassium target is bombarded by a 6 keV Ar^+ ion beam, which ion beam is produced by a uno-plasmatron source. By means of two slits the sputtered potassium atoms are collimated, giving a beam of atoms in the energy range of 0.35 to 16.5 eV. A 6% resolution slotted-disk velocity selector is placed in between the atom source and the collision chamber for velocity selection. The detector is a surface ionization platinum tungsten wire. With this apparatus total cross sections have been measured for the system K–He in the velocity range 1400 m/sec to 9000 m/sec. The velocity dependence of the cross section interpreted as an inverse power potential dependence gives s = 11. Author

N67-38698# Cornell Aeronautical Lab., Inc., Buffalo, N. Y.
ON THE DESIGN OF EXPERIMENTS WITH A SHOCK-TUBE-DRIVEN MOLECULAR BEAM
G. T. Skinner *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 423–441 refs (See N67-38681 23-06)

Some theoretical and experimental considerations which govern the design of typical experiments are discussed. Particular examples include a theoretically-attractive experiment, involving the measurement of the small-angle recoil of target particles, which has some features in common with chemical sampling. Experimental problems encountered with the use of a quadrupole mass spectrometer as detector for this work are discussed. Some comments are also made on the interrelationship between analytical problems in data reduction and experimental operating conditions, as encountered in designing differential cross section experiments. Author

N67-38718# Kernforschungszentrum, Karlsruhe (West Germany).
ELECTRON RADIAL WAVE FUNCTION FOR POSITRON BETA DECAYS
Wolfgang Buehring (Heidelberg Univ.) Apr. 1967 5 p refs
(KFK-559)

It is pointed out that the tables of electron radial wave functions by Bhalla and Rose are incorrect as far as positrons are concerned. Author

N67-38723# Imperial Coll. of Science and Technology, London (England). Dept. of Physics.
COHERENT SOFT PHOTON STATES AND INFRA-RED DIVERGENCES. I. CLASSICAL CURRENTS
T. W. B. Kibble Apr. 1967 38 p refs
(Grant AF-EOAR-12-67)
(ICTP/67/15; AFOSR-67-1599; AD-655881)

As a first step towards a treatment of soft photon processes which is free of infrared divergences and avoids the necessity of introducing a fictitious photon mass, the specification of asymptotic photon states belonging to non-Fock representations is discussed. As in the work of Chung, a basis consisting of generalized coherent states is used, but in contrast to his work, these states are rigorously defined in terms of von Neumanns infinite tensor product. It is shown that the states must be given an additional label which serves to distinguish various 'weakly equivalent' vectors, and which corresponds formally to an infinite phase factor. A non-separable Hilbert space H sub IR is defined (as a subspace of the infinite tensor product space) which may be regarded as the space of all possible asymptotic photon states. The interaction of the electromagnetic field with a prescribed classical current distribution is discussed, and it is shown that a unitary S operator all of whose matrix elements are finite may be defined on H sub IR. Author (TAB)

N67-38793 Bhabha Atomic Research Centre, Bombay (India).
DYNAMICS OF LIQUID CD_4 FROM COLD NEUTRON SCATTERING
G. Venkataraman, B. A. Dasannacharya, and K. R. Rao 1967 39 p refs
(BARC-286)

The scattering of 4.1 Å neutrons by liquid CD_4 at 95°K has been studied at several angles of scattering covering the first liquid diffraction peak. The spectra are strikingly different from those observed in liquid CH_4 with the quasielastic peak being very much more prominent than in liquid CH_4 at large scattering angles. Expressions are derived for the scattering of slow neutrons by a monomolecular system under the assumption of no vibrational scattering and weak anisotropic forces. In applying the theory to liquid CD_4, two models are considered. In both models, the single particle translational motions are assumed to have a simple diffusion behaviour, while collective motions are described by an intermediate scattering function with a structure dependent damping. The rotations are treated as free in one model and as hindered in the other. The first and second order relaxation functions for the hindered rotator, are derived from infrared and Raman data respectively. Both models make essentially the same predictions for the quasielastic widths, and these are found to be in fair agreement with experiment. Author

N67-38798# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics.

MASS FORMULAE IN LADDER REPRESENTATIONS OF GROUP U(6,6) [MASSOVYE FORMULY V LESTNICHNYKH PREDSTAVLENIYAKH GRUPPY U(6,6)]

A. V. Nikolov 1967 10 p refs In RUSSIAN
(JINR-P2-3407)

On the basis of natural physics assumptions a mass operator is constructed which acts in the space of the ladder series of unitary representations of group U(6,6). This operator is used to obtain mass formulas for baryons and mesons under the assumption that they are classified according to the representations mentioned. The relations obtained will agree with experiment: in the case of baryon 56-plet the relative errors do not exceed 0.8% (formulas for the first mass powers) and in the case of meson nonets with spin-parity 0^-, 1^-, and 2^+ they do not exceed 0.5% (formulae for quadratic masses). Author (NSA)

N67-38800# Virginia Univ., Charlottesville. Research Labs. for the Engineering Sciences.

THE INTERACTION OF HEAVY keV IONS WITH GASES PROGRESS REPORT, JUN. 1, 1966–MAY 31, 1967

John W. Boring Jun. 1967 17 p refs
(Contract AT(40-1)-2911)
(EE-3930-104-67U; ORO-2911-8) CFSTI: HC $3.00/MF $0.65

Results of measurements of ionization in CO_2, C_2H_4, and C_2H_2 by keV ions of hydrogen, oxygen, and argon are reported. Equipment to be used for measurement of the inelastic energy loss in small-angle ion–atom scattering is described. A method is described for calculating the energy going into kinetic energy of gas atoms for the case of an ion passing through a polyatomic gas. NSA

N67-38816# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).

ANGULAR DISTRIBUTION OF ELECTRON PAIR PRODUCED BY POLARIZED PHOTON AT THE FRASCATI ELECTROSYNCHROTRON

G. Barbiellini, F. Grianti, T. Letardi, and R. Visentin 17 Jul. 1967 14 p refs *Its* Nota Interna No. 373
(LNF-67/49)

By measuring all of the projected angular distributions of 150 MeV protons using pair production and a visual technique, a polarization independent check is obtained that properly accounts for scattering effects. The data obtained by polarized photons at the Frascati electron synchrotron are independent of possible electronic inefficiencies because the same electronic master is used to detect the events which are polarization dependent as well as the normalization factors which are polarization independent. M.W.R.

N67-38823* Oak Ridge National Lab., Tenn. Neutron Physics Div.

GRAPHS OF SCATTERED PARTICLE ENERGIES VS SCATTERING ANGLES, AND GRAPHS OF CENTER-OF-MASS SCATTERING ANGLES VS LABORATORY SCATTERING ANGLES FOR NUCLEON–NUCLEON REACTIONS FROM 25 TO 3500 MeV AND FOR PION-NUCLEON REACTIONS FROM 25 TO 2500 MeV

Hugo W. Bertini, Miriam P. Guthrie, and Elsie H. Pickell 18 Aug. 1967 37 p
(NASA Order R-104(1))
(NASA-CR-88976; ORNL-TM-1945) CSCL 20H

Graphs are presented illustrating the laboratory energy of the scattered nucleon vs the laboratory energy of the incident nucleon where the scattering angle is a parameter for incident nucleon energies ranging from 25 to 3500 MeV. The same type of data is presented for pion–nucleon reactions with energies from 25 to 2500 MeV. Graphs of the scattering angle in the center-of-mass system vs the scattering angle in the laboratory system at various reaction energies for the same reactions and over the same energy ranges are presented. The data are applicable to the checking and the understanding of the results from an intermediate energy intranuclear cascade calculation. Author

N67-38836# Virginia Univ., Charlottesville. Dept. of Physics.

THEORETICAL NUCLEAR PHYSICS Progress Report

Morris E. Rose Jun. 1967 21 p refs
(Contract AT(40-1)-2915)
(ORO-2915-79) CFSTI: HC $3.00/MF $0.65

Nuclear structure is discussed from the viewpoint of (1) electromagnetic and weak interactions, (2) force models, (3) interactions with mesons (pions), and (4) atomic phenomena. Separation energies, angular distributions, particle capture, and scattering, are discussed. L.S.

N67-38843 Bhabha Atomic Research Centre, Bombay (India).

TWO CENTRE COULOMB AND EXCHANGE INTEGRALS

P. G. Khubchandani, K. C. Bhalla, and P. C. Hariharan 1967 10 p refs
(BARC-285)

Exchange integrals are expressed in terms of two-center Coulomb and overlap integrals by using Slater orbitals. The method of integral transforms is given, as are calculations for orbitals of the 1s and 2p type. The method presented is then extended to calculate the exchange integrals. M.W.R.

N67-38847# Comitato Nazionale per l'Energia Nucleare, Frascati (Italy).

EXTRACTION OF ELECTRON BEAMS FROM ELECTRON SYNCHROTRONS

A. Turrin 20 Jun. 1967 17 p refs Presented at the Intern. Conf. on Electromagnetic Interactions at Low and Intermediate Energies, Dubna, USSR, 7–15 Feb. 1967 *Its* Nota Interna No. 367
(LNF-67/39) CFSTI: HC $3.00/MF $0.65

Methods of extracting external bursts from electron synchrotrons are reviewed, and three ejections schemes are noted: (1) short burst techniques, with particle ejection during a single revolution by a suitable pulsed beam deflector; (2) Linac-like techniques, with particle ejection during a few revolutions by exciting a linear resonance between the radial betatron oscillations and the revolutions; and (3) long-burst techniques, with ejection during several thousand revolutions by exhibiting a nonlinear resonance between radial betatron oscillations and revolutions. Extraction efficiencies have reached values above 90%, and external beams have been produced that have the same optical properties as circulating beams. M.W.R.

N67-38861# California Univ., Berkeley. Lawrence Radiation Lab.

HYPERFINE STRUCTURE AND MAGNETIC MOMENT OF ^{110m}Ag AND SPIN OF ^{163}Tm

Stephen G. Schmelling (Ph.D. Thesis) 29 Mar. 1967 48 p refs
(Contract W-7405-ENG-48)
(UCRL-17460) CFSTI: HC $3.00/MF $0.65

The atomic-beam magnetic-resonance technique was used to measure the free-atom ground-state hyperfine-structure separation $\Delta\nu$, the nuclear magnetic moment μ_I, and the hyperfine-structure anomaly $^{109}\Delta^{110m}$ of 260-day ^{110m}Ag ($I=6$). The magnetic moment μ_I was obtained independently of $\Delta\nu$ by observing a $\Delta F=\pm1$ doublet at its field-independent point. The results are $\Delta\nu(^{110m}\text{Ag}) = +30313.756(4)$ MHz, $\mu_I(^{110m}\text{Ag})$ (uncorr) $= +3.587(4)$ nm, and $^{109}\Delta^{110m} = -2.47(12)\%$. A short experiment was also done to measure the nuclear spin of 108-min ^{163}Tm. The result of this experiment is $I=1/2$ for ^{163}Tm. Author (NSA)

N67-38864* Pittsburgh Univ., Pa. Space Research Coordination Center.
THEORETICAL ASPECTS OF ATOMIC COLLISIONS II
E. Gerjuoy 6 Oct. 1967 16 p refs
(Grants NGR-39-011-035; NsG-416; Contract DA-31-124-ARO(D)44
(NASA-CR-85361; SRCC-58) CSCL 20H

A conference paper is presented on recent developments relating to classical methods, variational methods and bounds, and Faddeev equations. Emphasis is on electron-atom collision theory. A method for calculating cross sections for complicated collisions using extremely simple and classical methods is assessed. Variational methods and bounds are discussed in conjunction with theorems on cross sections and determinations of a particular functional form. Elements of Faddeev equations are evaluated. It is concluded that the equations can be generalized to systems of four or more particles, but it is unlikely that they will have practical application in atomic collisions bringing together more than three interacting particles. E.C.

N67-38873# Du Pont de Nemours (E. I.) and Co., Aiken, S. C. Savannah River Lab.
RADOS: A CODE TO ESTIMATE GAMMA DOSE FROM A CLOUD OF RADIOACTIVE GASES
Roger E. Cooper Jun. 1967 23 p refs
(Contract AT(07-2)-1)
(DP-1098) CFSTI: HC $3.00/MF $0.65

RADOS is a computer code that represents the finite spatial distribution of airborne source material as an infinite number of line sources. The code provides a means of rapidly calculating whole body gamma dose from a finite cloud of radioactive material. The simplifying assumptions used to minimize computation time are: (1) The material release is instantaneous and results in a radioactive cloud of unit thickness in the X or downwind direction. (2) There is no change in the size and shape of the cloud during passage over the effective range of the receptor. (3) The gamma buildup factors can be expressed analytically with sufficient accuracy. These assumptions limit the applicability of RADOS as follows: the material release should occur over a relatively short time; the receptor distance should be more than 600 meters downwind from the release point; and the gamma energies should be in the specified range. A 4-group, 12-isotope, 1-receptor-point problem requires approximately 1.75 seconds on the IBM System/360-65. Author (NSA)

N67-38906# Michigan Univ., Ann Arbor. Randall Lab. of Physics.
DIFFRACTION MODEL FOR STRONG INTERACTIONS AND THE SHRINKAGE OF THE DIFFRACTION PEAK
A. D. Krisch [1966] 17 p refs Presented at the Theoret. Phys. Inst., Colorado Univ., Boulder, Colo., Summer, 1966
(Contract AT(11-1)-1112)
(COO-1112-104) CFSTI: HC $3.00/MF $0.65

The diffraction model for strong interactions at high energies is considered. A model with a spherically symmetric interaction probability density which is squashed down in the direction of the motion by the Lorentz contraction is assumed. This model leads to the prediction that the differential elastic scattering cross section $d\sigma/dt$ should depend only on $\beta^2 p_i^2$. When the p+p and π+p elastic data are plotted against this variable, the energy dependence is removed. Thus this model seems to offer a kinematic explanation for the well-known shrinkage of the diffraction peak. NSA

N67-38928# Brookhaven National Lab., Upton, N. Y.
TABLES FOR ELECTRON WAVEFUNCTIONS AND ASSOCIATED DATA
E. L. Church Dec. 1966 119 p refs
(BNL-50002) CFSTI: HC $3.00/MF $0.65

The role of the penetration effect in internal conversion is reviewed, and a collection of formulas for the analysis of such effects in the K and L shells is provided. Tables of the bound and free electron wave functions at the nucleus, which appear as normalization constants, are given. These results, which include the effects of the finite nuclear size and atomic screening, are derived from the tabulations of Band, Guman, and Sogomonova, which represent intermediate steps in the interval-conversion-coefficient calculations of Silv and Band. Author (NSA)

N67-38960# Illinois Univ., Urbana. Dept. of Chemistry and Chemical Engineering.
DIPOLE–DIPOLE INTERACTIONS OF A SPIN-1/2 NUCLEUS WITH A QUADRUPOLE-COUPLED NUCLEUS
D. L. Vanderhart, H. S. Gutowsky, and T. C. Farrar 20 Jun. 1967 9 p refs Submitted for publication
(Contract N00014-66-C0010-A04)
(TR-11; AD-655121)

In recent NMR experiments, the dipolar broadening of the proton resonance in solid HMN(CO)5 and HCO(CO)4 has been used to estimate the metal–hydrogen bond distance. The M–H bond distances thus obtained are exceptionally short, 1.28 A for MN–H and 1.42 A for CO–H. However, the analyses were based on the Van Vleck second moment expression which assumes that the nuclei are quantized in the direction (Z) of the static magnetic field HO and which therefore neglects any quadrupole coupling effects at the metal nucleus. This communication describes a theoretical analysis and numerical calculations for a two-spin (1/2, 7/2 system, having axial symmetry along the internuclear vector R and quadrupole coupling at the spin-7/2 nucleus. It is found that the second moment M2 of the spin-1/2 nucleus may be as much as 1.84 times its value in the absence of the quadrupole coupling. Therefore, the M–H bond distances reported previously may be as much as 12% too small. Author (TAB)

N67-38961# Israel Program for Scientific Translations, Ltd., Jerusalem.
DOSIMETRY AND RADIATION PROTECTION
L. R. Kimel', ed. 1966 148 p refs Transl. into ENGLISH of the book "Voprosy Dozimetrii i Zashchity ot Izluchenii" Moscow, Atomizdat, 1965 Published for AEC and NSF *Its* Collection of Papers No. 4
(AEC-TR-6719; IPST-Cat.-1825)

Selected articles on radiation protection and dosimetry are presented. These articles pertain to neutron, gamma and proton radiation shielding and scintillation spectrometry. For individual titles see N67-38962–N67-38984.

N67-38962# Israel Program for Scientific Translations, Ltd., Jerusalem.
NEUTRON DOSE COMPOSITION IN SHIELDING MATERIALS
E. A. Kramer-Ageev, V. P. Mashkovich, and V. K. Sakharov *In its* Dosimetry and Radiation Protect. 1966 p 1–6 refs (See N67-38961 23-24)

Calculations were made of dose distributions in water, carbon, beryllium, concrete, and iron from the limiting energies of 0.5, 1.0, and 1.5 MeV between the intermediate and fast neutron groups. The results were compared with earlier data. An estimation of the accuracy of the conventional fast-neutron detectors was made. NSA

N67-38963# Israel Program for Scientific Translations, Ltd., Jerusalem.
MEASURING EPITHERMAL NEUTRON SPECTRA WITH RESONANCE MONITORS
V. N. Avaev and Yu. A Egorov *In its* Dosimetry and Radiation Protect. 1966 p 7–18 refs (See N67-38961 23-24)

A selection of radioactive resonance monitors for neutron spectroscopy in the epithermal region is presented. The thirteen

monitors described recover a sufficiently accurate spectral distribution in the energy range from 0.45 eV to 6 keV. Author (NSA)

N67-38964# Israel Program for Scientific Translations, Ltd., Jerusalem.
INTERFACIAL ENERGY DISTRIBUTION OF NEUTRONS
V. G. Dvukhsherstnov and V. A. Dulin *In its* Dosimetry and Radiation Protect. 1966 p 19–22 refs (See N67-38691 23-24)

Measurements were made of water-environmental interfacial energy distributions of neutrons from a point source of fast neutrons with a mean energy of 3.25 MeV. The following shielding materials were investigated: water (12 cm), graphite (20 cm), aluminum (10 cm), iron (10 and 15 cm), nickel (8 and 12 cm), and lead (12 cm). The measurements were made in barrier geometry: the detector was set at the environment–water interface at the point where the normal through the neutron source met the interface. NSA

N67-38965# Israel Program for Scientific Translations, Ltd., Jerusalem.
SOLUTION OF NEUTRON AGE EQUATION FOR A PLANE COSINE-LAW SOURCE
Yu. A. Anokhin and L. R. Kimel' *In its* Dosimetry and Radiation Protect. 1966 p 23–28 refs (See N67-38961 23-24)

A solution was derived for the neutron age equation for a plane cosine source. This solution is applied to determine the buildup of intermediate neutrons. NSA

N67-38966# Israel Program for Scientific Translations, Ltd., Jerusalem.
DIFFUSION OF NEUTRONS IN A POLARIZING MEDIUM
Yu. N. Kazachenkov and V. V. Orlov *In its* Dosimetry and Radiation Protect. 1966 p 29–43 refs (See N67-38961 23-24)

Kinetic equations are developed for the diffusion of neutrons in a polarizing medium. The maximum possible change in the diffusion coefficient resulting from polarization is calculated. NSA

N67-38967# Israel Program for Scientific Translations, Ltd., Jerusalem.
TREATMENT OF INTERMEDIATE-NEUTRON SPECTRA TAKEN WITH A TIME-OF-FLIGHT SPECTROMETER
E. A. Kramer-Ageev and V. S. Troshin *In its* Dosimetry and Radiation Protect. 1966 p 44–49 (See N67-38961 23-24)

Methods for the treatment of instrumental spectra obtained with a time-of-flight spectrometer are described. Different techniques for approximate solution of systems of integral equations are evaluated. Author (NSA)

N67-38968# Israel Program for Scientific Translations, Ltd., Jerusalem.
A SIMPLE METHOD FOR STUDYING CONTINUOUS FAST-NEUTRON SPECTRA
G. G. Doroshenko and V. G. Zolotukhin *In its* Dosimetry and Radiation Protect. 1966 p 50–53 refs (See N67-38961 23-24)

A simple method for the treatment of instrumental spectra of fast neutrons obtained with a single-crystal spectrometer is proposed. The method is based on a single n-p scattering and recovers the true spectrum to within 10–15%. Author (NSA)

N67-38969# Israel Program for Scientific Translations, Ltd., Jerusalem.
A STUDY OF SHIELDING PROPERTIES OF MATERIALS WITH THE AID OF FISSION CHAMBERS
L. V. Konstantinov and Yu. M. Serebrennikov *In its* Dosimetry and Radiation Protect. 1966 p 54–58 refs (See N67-38961 23-24)

The design, operation, and counting responses of fission chambers are discussed. NSA

N67-38972# Israel Program for Scientific Translations, Ltd., Jerusalem.
REFLECTION OF GAMMA-RADIATION EMERGING FROM A SEMI-INFINITE ACTIVE WATER MEDIUM BY AIR
V. V. Pavlov *In its* Dosimetry and Radiation Protect. 1966 p 71–73 refs (See N67-38961 23-24)

Approximate formulas are given for gamma–gamma currents and fluxes emerging from a semi-infinite source with uniformly distributed activity. NSA

N67-38973# Israel Program for Scientific Translations, Ltd., Jerusalem.
ANGULAR ENERGY DISTRIBUTION OF GAMMA RADIATION FROM A SEMI-INFINITE MEDIUM WITH UNIFORMLY DISTRIBUTED ISOTROPIC SOURCES
V. V. Pavlov *In its* Dosimetry and Radiation Protect. 1966 p 74–76 refs (See N67-38961 23-24)

It is pointed out why an approximate relation previously developed by the author for the angular energy distribution of γ radiation emerging from a semi-infinite medium is inaccurate. An alternative solution is then used to determine the energy flux in water. NSA

N67-38974# Israel Program for Scientific Translations, Ltd., Jerusalem.
SPECTRAL-ANGULAR DISTRIBUTION OF RADIATION FROM THE LATERAL WALLS OF A CHANNEL IN SHIELDING
A. M. Panchenko *In its* Dosimetry and Radiation Protect. 1966 p 77–79 refs (See N67-38961 23-24)

The spectral angular distribution of scattered radiation from a plane unidirectional source in iron was derived using the model of a point unidirectional source. The theoretical results were applied to calculate the spectral-energy distributions of stray radiation emerging from lateral walls of channels. NSA

N67-38975# Israel Program for Scientific Translations, Ltd., Jerusalem.
SOME EXPERIMENTAL RESULTS CONCERNING THE SHIELDING PROPERTIES OF MATERIALS IN RELATION TO HIGH-ENERGY PROTONS
V. P. Afanas'ev, A. M. Biskupchuk, V. E. Dudkin, E. E. Kovalev, V. G. Kuznetsov et al *In its* Dosimetry and Radiation Protect. 1966 p 80–89 refs (See N67-38961 23-24)

Experimental results are presented on high-energy proton dose attenuation in various shields. The experimental data are compared with theoretical findings. NSA

N67-38976# Israel Program for Scientific Translations, Ltd., Jerusalem.
CORRECTIONS FOR ABSORPTION IN ABSOLUTE BETA-ACTIVITY MEASUREMENTS
V. F. Baranov *In its* Dosimetry and Radiation Protect. 1966 p 90–92 refs (See N67-38961 23-24)

Corrections for absorption in absolute β-activity measurements with end-window counters are presented. The corrections are based on the extrapolation of the absorption curve to zero absorption thickness and assuming exponential absorption of β-radiation in matter. NSA

N67-38977# Israel Program for Scientific Translations, Ltd., Jerusalem
ABSORPTION OF MONOENERGETIC AND BETA-SPECTRUM ELECTRONS IN ALUMINUM

V. F. Baranov *In its* Dosimetry and Radiation Protect. 1966 p 93–99 refs (See N67-38961 23-24)

The absorption of monoenergetic electrons from 0.1 to 1.5 MeV in aluminum was measured using a magnetic electron monochromator. End-window counters enclosed in a vacuum chamber were used as detectors. The absorption curves for some β-emitters were also calculated from the experimental data. NSA

N67-38978# Israel Program for Scientific Translations, Ltd., Jerusalem.

END LOSSES IN FILLED COUNTERS

V. M. Kolobashkin, A. A. Greshilov, and N. P. Ushakova *In its* Dosimetry and Radiation Protect. 1966 p 100–102 refs (See N67-38961 23-24)

When the activity of gaseous β-emitters is measured with a single filled cylindrical counter, the counting losses produced by field reduction at the counter ends can be allowed for by introducing a correction $\gamma=(n-N/N)$ where n is the number of disintegrations in unit time and N the recorded counting rate. NSA

N67-38981# Israel Program for Scientific Translations, Ltd., Jerusalem.

ESTIMATING THE RELATIVE CONTRIBUTION FROM DIFFERENT SCINTILLATION COMPONENTS

G. G. Doroshenko *In its* Dosimetry and Radiation Protect. 1966 p 109–110 refs (See N67-38961 23-24)

The importance of the electron time-of-flight spread in the photomultiplier for evaluating the relative contribution from the different scintillation components is discussed. Author (NSA)

N67-39038 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France). Faculte des Sciences.

UNITARITY AND RADIATIVE DECAY PROCESSES

M. K. Gaillard (Ph.D. Thesis) Jul. 1967 25 p refs

(TH-206)

By means of the unitary condition, the contribution of radiative $\pi\pi$ scattering to the matrix elements for radiative decay processes such as $K \rightarrow 2\pi\gamma$ was studied. In particular, the final state interaction phases associated with direct emission (as distinguished from Bremsstrahlung) amplitudes in radiative decays depend on the importance of the corresponding direct emission amplitudes in radiative scattering. Considered separately are the cases of T-invariance and T-violation, assuming CPT invariance throughout. In the limit of T-invariance it was found that the phase of a direct emission amplitude corresponding to a final state dipion system of angular momentum I is the appropriate $\pi\pi$ scattering phase shift δ_I in the following cases: (1) The corresponding amplitude is forbidden in radiative scattering (e.g. magnetic emission for all I in spin-zero boson decays). (2) The nonradiative decay is forbidden (e.g. η decay and K_2^0 decay). For $K^{\pm}$ decay the nonradiative decay is suppressed relative to direct emission by the $|\Delta I| = 1/2$ rule; hence the approximation of a phase δ_I for electric as well as magnetic amplitudes may be reasonable. For the case of T-violation, the partial wave amplitudes $D_I(\bar{D}_I)$ for direct emission in radiative $K(\bar{K})$ decay into a final dipion state of angular momentum I were found to be related by $\bar{D}_I = \pm D_I^{\dagger} \exp(2i\delta_I)$ if condition (1) or (2) above holds. Also considered is the case in which these conditions do not hold. It was found that CP violating effects such as a difference in rates and spectra for radiative K^+ and K^- decays, or an interference between K_L and K_S amplitudes remain nonvanishing in the latter case. Author

N67-39042# Japan Atomic Energy Research Inst., Tokyo.

ON THE STUDY OF INTENSIFICATION OF FRONT LEAD SCREEN FOR γ-RAY RADIOGRAPHY

Akira Ohno and Toshiaki Nojiri Jun. 1967 11 p refs Submitted for publication

(NSJ-TR-86)

The effects of lead screens for γ-ray radiography are the intensified action by the secondary electrons and the shielded one in the low energy scattering of γ-rays by surrounding materials. In this paper, the intensification of front lead screens with several thickness for the ^{60}Co, ^{137}Cs and ^{192}Ir γ-ray radiography without specimen is studied by means of experiments and calculations. The exposure dose to get 1.75 photographic density for Sakura X-ray film industrial type N are determined by experiments for several thick foils of lead with standard developing method. Angular distributions of photoelectric electrons and Compton electrons by interaction of γ-ray photons with lead atoms are calculated. For photographic emulsion itself, the calculations are done on the assumption that the content of AgBr in the emulsion is 50 weight %, the density is 2.0 g/cm^3, and the thickness is 20 μ. Some of these secondary electrons are absorbed in film emulsion and the blackening due to γ-rays are proportional to the energy loss under the electron ionization in the emulsion. In the estimations, it is important how much electron beams are absorbed in the lead foil and the film emulsion. Agreement with experiments and calculations are sufficient except the part of thin layer of lead screens for ^{60}Co in the reduction of intensification. It is recognized by experiment and calculation that its part is intensified by the secondary electrons of plastic plate of cassette for light tight and the lead screens behave like absorber. By the calculated results, the maximum intensification factors of front lead screens are about 2.5 for ^{60}Co γ-ray source with 0.3 mm thick lead screen, 2.3 for ^{137}Cs source with 0.1 mm screen, and 3.3 for ^{192}Ir source with 0.07 mm screen. Author

N67-39052 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France). Faculte des Sciences.

STRONG DECAYS OF BARYONIC RESONANCES $3^-/2$ AND PSEUDOSCALAR MESONS AND SU(3) SYMMETRY

E. Cremmer Sep. 1967 16 p refs

(TH-214)

In this paper, we study the strong decays of baryonic resonances $3^-/2$ in baryons and pseudoscalar mesons, in the framework of SU(3) symmetry. It is shown that the results are in agreement with experiment by using a Lorentz invariant form for the transition matrix element and taking into account the Y_0^+–Y_0^0 mixing. Author

N67-39059 India. Dept. of Atomic Energy, Bombay.

EVALUATION OF NEUTRON CROSS SECTIONS ON THE BASES OF OPTICAL AND STATISTICAL MODELS

S. B. Garg, K. Balasubramanian, and V. K. Shukla 1967 45 p refs

(BARC-279)

In order to produce accurate calculation of the neutronics of reactors, precise knowledge of inelastic and elastic cross sections and their angular distributions is desired. Optical model and Hauser–Feshbach theory have been used to compute total, elastic and inelastic cross sections of several materials which are of special interest from the point of view of a reactor physicist. These calculations also serve to test the validity of these two nuclear models which are frequently used in the continuum energy region. In general, the calculated total cross section agrees well with the measured one. The data presented herein will be incorporated into multigroup computer codes for reactor analysis. Strength functions can also be calculated on the basis of optical model. Author

N67-39078# Akademiya Nauk SSSR, Novosibirsk. Institut Yadernoi Fiziki.

ENERGY SPECTRUM OF AN ELECTRON IN A DISTORTED, ONE-DIMENSIONAL, PERIODIC LATTICE [OB ENERGETICHESKOM SPEKTRE ELEKTRONA V "ISPORCHENNOI" ODNOMERNOI PERIODICHESKOI RESHETKE]

G. M. Zaslavskii and R. Z. Sardeev 1966 10 p refs in RUSSIAN *Its* Preprint No. 13

(NP-16782)

One of the most timely applications of the method for determining the density distribution of energy levels of disordered systems relates to the problem of determining the energy spectrum of the electron in a "distorted" lattice or amorphous disordered systems. Difficulties are encountered in the determination of the spectral density near the edge of the permitted energy ranges because in that case even an extremely low level of disorder affects strongly the nature of the spectrum. In order to avoid this difficulty, models were developed to find an asymptotic solution for the spectral density. Such a one-dimensional, distorted lattice model was examined, considering the case, in which the potential contains regular periodic additives. If the additives follow a Poisson distribution, they are not located at the junction points of the lattice and the edge of the permitted zone will be shifted. NSA

N67-39093# Los Alamos Scientific Lab., N. Mex.
"SHELLS" IN DEFORMED NUCLEI
V. M. Strutinskii 1967 70 p refs Transl. into ENGLISH from Russian Rept. IAE-1350
(LA-TR-67-38; IAE-1350) CFSTI: HC $3.00/MF $0.65

The effects of shells in deformed nuclei are discussed including shell corrections to the energy and shell density of nucleon levels correlation of the shell correction to the energy and shell density of upper nucleon levels, the distribution of nucleon shells in deformed nuclei, equilibrium deformations of nuclei, the transition between spherical and nonspherical equilibrium shapes, second minima of the deformation energy, and anomalies in the masses and fissionability of nuclei. The predictions of the single-particle model are compared with calculations using the shell-correction method. NSA

N67-39094# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
PRODUCTION OF THE ISOBAR N_{33}^{*++} AND THE $\pi\pi$ INTERACTION IN THE ISOSPIN 2 STATE, STUDIED IN THE REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ AT 2.75 GeV/c [PRODUCTION DE L'ISOBARE N_{33}^{*++} ET INTERACTION $\pi\pi$ DANS L'ETAT D'ISOSPIN I = 2, ETUDIEES DANS LA REACTION $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ A 2.75 GeV/c]
Jean Alitti (Ph.D. Thesis—Paris Univ., Orsay, France, 6 Jun. 1966) 1967 81 p refs In FRENCH
(CEA-R-3035)

A study of the reaction $\pi^-p \rightarrow p\pi^+\pi^-\pi^-$ at 2.7 GeV/c was carried out in an 81 cm liquid hydrogen bubble chamber at the proton synchroton. One observes that the abundant N_{33}^{*++} (1236 MeV) isobar production occurs predominantly backwards in the center of mass of the reaction. This feature suggests a peripheral production mechanism with π exchange. The validity of this hypothesis, which allows one to study the $\pi^-\pi^-$ interaction within the frame of the Chew and low model is verified. Among other results one finds for the isospin-2 state the values of the elastic $\pi\pi$ cross section and of the S and D wave phase shifts. Author (NSA)

N67-39135# European Atomic Energy Community, Ispra (Italy).
COLLECTRONS: CONTINUOUS MEASUREMENT OF THERMAL NEUTRON FLUXES [LES COLLECTRONS: MESURE EN CONTINU DES FLUX DE NEUTRONS THERMIQUES]
M. Grin Aug. 1967 54 p refs In ITALIAN; ENGLISH summary
(EUR-3567.f)

Collectrons are self-powered detectors by means of which snap measurements of neutron fluxes can be effected. They consist of a sensitive component, a short-period beta emitter, and a sheath or collector. When the circuit is closed on to an appropriate gauge, a current proportional to the neutron flux can be measured. The report cites certain principles of physics concerning neutron fluxes, cross-sections and beta radioactivity phenomena; and considers the chief problems involved in collectron technology, wiring, and measuring methods. A theoretical section, containing all the physical data on the principal types of detector used (silver, rhodium and vanadium), gives the calculation of the current produced and the principal correction formulae by which allowance is made for the neutron shielding and flux depression and the beta absorption in the detector. Author

N67-39146 Laboratoire de Physique Theorique et des Hautes Energies, Orsay (France).
ON THE Q^2 DEPENDENCE OF THE KAON FORM FACTORS
B. d'Espagnat and M. K. Gaillard Jul. 1967 7 p refs
(TH/211)

The Fubini–Furlan method is applied to the problem of the q^2 dependence of the K_{l3} form factors. It is shown that if $f_+(q^2)$ varies slowly, then a rapid variation of $f_-(q^2)$ can reasonably be expected. Possible means of extracting theoretical information from data on $f_-(q)^2$ are briefly discussed. Author

N67-39153# Princeton–Pennsylvania Accelerator, Princeton, N. J.
ENERGY DEPENDENCE OF THE FORM FACTOR IN $K_{\pi 3}^+$
Richard L. Imlay May 1967 72 p refs
(Contract AT(30-1)-2137)
(PPAD-621F) CFSTI: HC $3.00/MF $0.65

The decay $K^+ \rightarrow e^+ + \pi^0 + \nu$ was investigated in a spark chamber and counter experiment at the Princeton–Pennsylvania Accelerator. The K^+ mesons were stopped in a block of beryllium. A threshold gas Cherenkov counter was employed to select the positronic decay mode and the positron momentum was obtained with a series of thin plate spark chambers located in a magnetic field between the K^+ stopping region and the Cherenkov counter. The directions of the gamma rays from the π^0 decay were measured with a pair of lead plate spark chambers. A Dalitz plot of 1393 $K_{\pi 3}^+$ events agrees well with vector coupling. The π^0 energy spectrum was investigated to determine the energy dependence of the strong interaction form factor $f_+(q^2)$ where q^2 is the square of the four momentum transferred to the leptons and equals $M_k^2+M_\pi^2-2M_kE_\pi$ for K^+ decays at rest. Author (NSA)

N67-39217# Atomic Weapons Research Establishment, Aldermaston (England).
COMPUTED f(χ) CURVES FOR THE CORRECTION OF X-RAY ABSORPTION IN ELECTRON-PROBE MICROANALYSIS
G. V. T. Ranzetta and V. D. Scott Jun. 1967 19 p refs
(AWRE-O-28/67) CFSTI: HC $3.00/MF $0.65

Electron-probe microanalysis results normally have to be corrected for the absorption of x rays in the specimen being analyzed to make them fully quantitative. This correction may be carried out using f(χ) curves which give the fraction of the generated x rays that emerge at the surface of a sample as a function of probe voltage, mass absorption coefficient, and take-off angle. A series of f(χ) curves was calculated using the computer program of Archard and Mulvey (Archard and Mulvey: Proceedings of The Third International Symposium on X-Ray Optics and X-Ray Microanalysis, Stanford Univ., 1962). These curves, covering a wide range of elements and probe voltages, should provide a useful guide to x-ray absorption in pure metals. Author (NSA)

N67-39235* Cambridge Univ. (England). Inst. of Theoretical Astronomy.
ON THE GENERAL CORRESPONDENCE BETWEEN FIELD THEORIES AND THE THEORIES OF DIRECT INTERPARTICLE ACTION
J. V. Narlikar [1967] 14 p refs
(Grant NsG-695)
(NASA-CR-89344) CSCL 20H

It is well known that classical electrodynamics can be described both as a field theory and as a theory of direct interparticle

action. In the present paper it is shown that, provided certain general conditions are satisfied, fields of arbitrary spin have their counterparts in direct particle fields. This correspondence between the two formalisms is established in the Riemannian space-time used for general relativity. Author

N67-39305# Paris Univ., Orsay (France). Laboratoire de Physique Theorique et Hautes Energies.

CURRENT: DIVERGENCE COMMUTATOR

F. Capra May 1967 7 p refs

(NP-16842; TH-202)

The equal time commutator of an axial current and an axial divergence is calculated with the help of a low-energy theorem of pion–nucleon scattering. Comparing the result with the σ model, a relation between the mass, the coupling constant and the vertex form factor of the σ meson is derived. The result is also found to be consistent with the estimates of Weinberg, thus justifying the usual neglect of terms containing current-divergence commutators. Author (NSA)

N67-39306# Lyon Univ. (France). Institut de Physique Nucleaire.

GRAPHICAL TREATMENT OF THE GEOMETRY OF A NUCLEAR PHYSICS PROBLEM: APPLICATION TO NONLOCAL POTENTIALS [TRAITEMENT GRAPHIQUE DE LA GEOMETRIE D'UN PROBLEME DE PHYSIQUE NUCLEAIRE. APPLICATION AUX POTENTIELS NON-LOCAUX]

Jean Noel Massot (Ph.D. Thesis) Dec. 1966 181 p refs In FRENCH

(LYCEN-6663)

The Yutsis et al. graphic representation of the Racah algebra is not complete in three points. It ignores the spherical harmonic functions, the irreducible tensors, and the rotation matrices. This question is studied and developed. The graphic methods thus developed are extremely general and can be used with any problem. The second point in the incompletion of the representation is that when a physics problem necessitates the decoupling of a spin J into "n" spins j; it is necessary to make the decomposition step by step and analytically with the aid of Clebsch–Gordon coefficients. The graphic method can be used only after conversion of the Clebsch–Gordon symbols into "3-j" coefficients. In order to avoid the analytical decomposition and the conversion (C–G) → ("3–j") then the transcription of these latter symbols into graphic elements, triangular diagrams are introduced. This scheme is completed with the aid of an algorithm which makes it possible to construct instantaneously the initial phase. It is then seen how the ensemble of the method makes it possible to effect analytically all the operations bearing on the elements encountered in the kinetic moment theory. A nonlocal stripping interaction is then studied and the general expression for the differential cross section is given. Author (NSA)

N67-39309# Ceskoslovenska Akademia Ved, Rez. Ustav Jademeho, Vyzkumu.

WAVE FUNCTIONS FOR MIXED CONFIGURATIONS AND THE RACAH ALGEBRA OF SU(4) GROUP

V. J. Kukulin, L. Majling, and Yu. F. Smirnov May 1967 20 p refs

(UJV-1834)

A new method of construction of many-nucleon wave functions with a given Young tableau for two unfilled shells is described. The Racah algebra of the SU(4) group is employed for obtaining the many-particle coefficients of fractional parentage as well as calculations of matrix elements of one- and two-particle operators. Author

N67-39324 Rochester Univ., N. Y. Physics and Astronomy Dept.

GENERAL VARIATIONAL EQUATIONS FOR STATIONARY AND TIME DEPENDENT STATES

D. J. Rowe 8 Sep. 1967 15 p refs Submitted for publication

(Contract AT(30-1)-875)

(UR-875-217)

General variational equations are derived, for stationary and time dependent states, which are valid for arbitrary variations and are not necessarily restricted to closed shell nuclei. It is shown that the stationary state equations converge to excited as well as ground state solutions and may therefore be useful, already in lowest order, for finding excited Hartree–Fock solutions. The time-dependent equations, which relate to the theory of small vibrations, are shown to be identical to the general equations of motion for nuclear excitations. The relationship between time-dependent Hartree–Fock theory and the stability condition for a stationary Hartree–Fock solution is shown to be general. The possibility of an imaginary root and the occurrence of a phase transition is interpreted. Author

N67-39329# Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation.

EFFECT OF TENSOR MESON EXCHANGE ON N–N SCATTERING

L. S. Azhgirei and V. I. Chizhikov 1967 7 p refs

(JINR-E1-3420)

The coupling constants of the scalar (σ), pseudoscalar (π), vector (ω and ρ) and tensor (f) mesons are determined by the least squares method from the elastic nucleon–nucleon scattering phase shifts. It is shown that the account of the tensor meson in terms of one-boson-exchange model leads to a better description of the experimental $^3P_{0,1,2}$ and $^3D_1$ phase shifts of N–N scattering in the energy region of 25–330 MeV. Author (NSA)

N67-39330# International Centre for Theoretical Physics, Trieste (Italy).

CLEBSCH–GORDAN COEFFICIENTS FOR THE LORENTZ GROUP. I: PRINCIPAL SERIES

R. L. Anderson, R. Raczka, M. A. Rashid, and P. Winternitz Jul. 1967 31 p refs

(IC-67/50)

Explicit expression for the Clebsch–Gordan coefficient for the unitary representations of the principal series for the SL(2,c) group is obtained. Their orthogonality and symmetry properties are discussed. Special cases of physical interest are dealt with in detail. Author (NSA)

N67-39331# Comitato Nazionale per l'Energie Nucleare, Rome (Italy).

A FORTRAN PROGRAMME FOR THE COUPLED-CHANNEL CALCULATION OF THE NEUTRON SCATTERING FROM ROTATIONAL EVEN–EVEN NUCLEI

F. Fabbri and A. M. Saruis 1967 39 p refs

(RT/FI-(67)10)

The program DANGFASI, which can be used to calculate the elastic scattering phase shifts, cross sections, and polarization for neutrons on even–even rotational nuclei using the coupled-channel method, is described. The mathematical formulation of the program, which is in FORTRAN IV for the IBM 7094, is presented. NSA

N67-39337 European Organization for Nuclear Research, Geneva (Switzerland).

ON THE THEORY OF QUADRUPLET REVERSAL [SUR LA THEORIE DU QUADRUPLET DE RETOURNEMENT]

R. Regenstreif 28 Aug. 1967 70 p refs In FRENCH

(CERN-67-22)

Geometric and electric parameter limits are studied that will cause quadrupole reversal in a high frequency separator at high energies, simultaneously with producing real and stigmatic images. Asymmetrical orientation for both symmetrical and asymmetrical geometries is considered, and mention is made of symmetrical quadrupole orientation. Normal quadrupole reversal was investigated for cases with equal and unequal slip spaces, and the calculation of angular entrance is included along with other detailed solutions. Transl. by M.W.R.

N67-39378*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

DETERMINATION OF TUNGSTEN RESONANCE ABSORPTION INTEGRALS BY ACTIVATION

Clarence R. Pierce and Donald F. Shook Washington, NASA, Oct. 1967 34 p refs

(NASA-TN-D-4137) CFSTI: HC $3.00/MF $0.65 CSCL 18J

The effective resonance integrals of tungsten 186 and tungsten 184 as contained in natural tungsten were obtained for foil thicknesses from 0.25 to about 10^{-7} centimeter. Thin-sample activations yielded values for the dilute resonance integrals of 443 ± 17 barns $((4.43 \pm 0.17)10^{-26}$ m^2) for W^{186} and 15 ± 2 barns $((1.5 \pm 0.2)\ 10^{-27}$ m^2) for W^{184}. Since the 18.8-electron-volt $(3.01 \times 10^{-18}$ J) resonance of W^{186} constitutes 92 percent of the dilute resonance integral for this isotope, and since the neutron scattering width for this resonance has been accurately measured, the present measurement provides an estimate of the radiative capture width. The scattering widths for the important resonances of W^{184} are also accurately known, and therefore an average capture width for this isotope was also estimated. Values of 0.041 ± 0.002 electron volt $((6.56 \pm 0.32)\ 10^{-21}$ J) for the capture width of the 18.8-electron-volt $(3.01 \times 10^{-18}$ J) resonance of W^{186} and 0.062 ± 0.007 electron volt $((9.93 \pm 1.12)\ 10^{-21}$ J) for the capture widths of the main resonances of W^{184} were obtained. The capture width obtained for the 18.8-electron-volt $(3.01 \times 10^{-18}$ J) resonance of W^{186} is lower than but in agreement with the reported neutron spectroscopy result of 0.045 ± 0.006 electron volt $((7.21 \pm 0.96)\ 10^{-21}$ J). Author

25 PHYSICS, PLASMA

Includes magnetohydrodynamics. For applications see: 28 Propulsion Systems.

N67-38075# Avco Corp., Wilmington, Mass. Missiles, Space and Electronics Group.

INTERACTION OF A HIGH CURRENT ELECTRICAL DISCHARGE WITH ITS SELF-INDUCED MAGNETIC FIELD IN THE PRESENCE OF GAS FLOW

A. C. Malliaris Wright-Patterson AFB, Ohio, ARL, Jan. 1967 196 p refs

(Contract AF 33(657)-11310)

(AVMSD-0085-67-RR; ARL-67-0007; AD-657339)

An electrical discharge is considered between two electrodes arranged axisymmetrically. Discharge currents are used up to 2500 amperes in a steady state and in the presence of a nitrogen flow rate of the order of a few hundred milligrams per second. The main objective is to determine quantitatively the importance of magnetoplasmadynamic effects in the acceleration of plasma. After a brief consideration of the analytical background, several experiments are discussed and the corresponding results are analyzed. It was determined that the self-magnetic field makes a substantial contribution, as high as 60 percent or higher in certain cases, to the acceleration of plasma. The particularly effective mechanism in these experiments seems to be the self-induced compression in the discharge which is also manifested as a cathode tip overpressure. It was determined that the overpressure in question depends strongly on the discharge current, but is drastically reduced in the presence of an externally applied magnetic field. An interesting by-product of pressure measurements at the cathode tip is the determination of the cathode spot radius which was found in the near vicinity of 5 mm with a small but detectable dependence on both the current and the pressure. Further experiments and experimental results are also presented from measurements of the impact pressure, the plasma velocity, and electric current density in the plasma flow. Author (TAB)

N67-38076# California Univ., Berkeley. Office of Research Services.

AN EXPERIMENTAL METHOD FOR THE STUDY OF INTERACTIONS BETWEEN DETONATION WAVES AND MAGNETIC FIELDS

Eric Arthur Lundstrom Jun. 1967 38 p refs

(Grant AF-AFOSR-129-67)

(AS-67-7; TN-3-67; AD-657354)

Reported here is the design and construction of an experimental apparatus for the study of the influence of electromagnetic fields on the structure of detonation waves. The apparatus consists of a detonation tube having a 3/4 inch square test section with axial magnetic and transverse electric fields. The structure of the detonation wave is recorded by the use of the soot film technique. Author (TAB)

N67-38127# Plasma Sciences Labs., Inc., Van Nuys, Calif.

DETERMINATION OF DEPARTURES FROM LOCAL THERMODYNAMIC EQUILIBRIUM IN ARC PLASMAS

H. N. Olsen, G. Bedjai, and R. E. Martindill Wright-Patterson AFB, Ohio, ARL, Mar. 1967 102 p refs

(Contract AF 33(615)-5149)

(ARL-67-0060; AD-655934)

The concept of local thermodynamic equilibrium was investigated both theoretically and experimentally. Equilibrium characteristic curves were constructed from absolute spectral intensities of the several species of radiation emitted by the free-burning argon arc plasma. Measurements were made over the pressure range $0.1 < or = P < or = 1.1$ atm. Complete local thermal equilibrium, in the sense that electrons and heavy particles have the same temperature, was observed for pressures above 0.3 atm. Transition probabilities measured in the course of the investigation were compared with those available in the literature. This comparison shows disagreement among investigators regarding the state of equilibrium existing even in the 1 atm plasma. Author (TAB)

N67-38138# National Research Council of Canada, Ottawa (Ontario). Gas Dynamics Section.

NORMAL REFLECTION OF A PLANE GASEOUS DETONATION WAVE IN A TUBE

A. H. Makomaski Apr. 1967 36 p refs

(NRC-9667; MT-58)

A method, together with a FORTRAN IV computer program, is presented for the calculation of the trajectory and properties of a shock wave generated on normal reflection of an idealized gaseous detonation wave in a tube. The detonation wave is assumed to be formed by energetic ignition resulting in zero detonation induction distance. The reflecting wall is assumed either to be set in motion at a constant velocity at the instant of reflection or to remain at rest. It is also assumed that the reflecting shock wave is plane and gamma constant throughout the burned gas. A comparison is made between calculation and experiment for normal reflection from a stationary wall of a $2H_2+O_2$ detonation wave (with gases at the initial pressure of 10 atm.), in a detonation tube 1 in. diameter and about 10 in. long. Author

N67-38142*# Rensselaer Polytechnic Inst., Troy, N. Y.
EXPERIMENTS IN LOW ENERGY PLASMAS
E. H. Holt and J. H. Noon Washington, NASA, Oct. 1967 36 p refs
(Grant NsG-48)
(NASA-CR-906; TR-67-1) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Research is described under three major headings; microwave studies of electron energy loss processes in afterglow plasmas, electromagnetic wave propagation through magnetoplasmas and studies of plasma transport and stability in the presence of magnetic fields. Author

N67-38250# Florida Univ., Gainesville. Electron Devices Lab.
COHERENT, TUNABLE, CW OSCILLATIONS IN A SMOOTH-BORE MAGNETRON—THE "PLASMA" MAGNETRON
Alan D. Sutherland Jul. 1967 140 p refs
(Grants AF-AFOSR-839-66; AF-AFOSR-839-67
(PM-2; AFOSR-67-1663; AD-657359)

Coherent, CW oscillations are generated in a smooth-bore magnetron when the end plates are operated at anode potential allowing the electrons of the discharge free access to them. These oscillations, which occur in a coaxial cavity whose lowest order resonant (TEM) mode is about 8.5 GHz, are continuously tunable over the frequency range from 800 mHz to 3,000 mHz by varying the magnetic field. The frequency is nearly, but not exactly, the electron cyclotron frequency. For this reason, this oscillation is referred to as the cyclotron mode, to distinguish it from other geometry-dependent modes which are observed to appear only with critical values of discharge current and magnetic field. Both modes of oscillation are observed only with pressure below 1 micron. At higher pressures, a plasma forms and oscillations, when observed, have the character of wide-band peaks of hash. TAB

N67-38255# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
CONTRIBUTION OF ELECTRO-OPTICS TO PLASMA RESEARCH [APPORT DE L'ELECTRO-OPTIQUE AUX ETUDES SUR LE PLASMA]
Alain Dillet, Claude Jacquot, and Pierre Stevenin Jun. 1967 30 p In FRENCH
(CEA-R-3237)

Two electro-optical devices useful for plasma diagnostics are described. The first includes two image converters and is able to record any luminous transient phenomenon (for instance, fast spectrography) with a photon gain sufficient to distinguish the physically observable luminous thresholds. The second makes use of the Faraday effect to measure magnetic fields without perturbation. A fast device has a pass band up to 30 MHz. A slower one can detect 1" of arc. Author (NSA)

N67-38269# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
BEAM-PLASMA INTERACTION IN A COLD-CATHODES PENNING DISCHARGE [INTERACTION FAISCEAU-PLASMA DANS UNE DECHARGE PENNING A CATHODES FROIDES]
Samuel Lazare Bliman (Ph.D. Thesis—Paris Univ., Orsay, France, 22 Jun. 1966) 1967 123 p refs In FRENCH
(CEA-R-3081)

The hf emissions from a cold-cathode reflex discharge are studied. An experimental law for the frequency variation shows that $f \alpha V^{1/2}$ discharged if B_0 and p are constant. If B_0 is made to increase, the frequencies change such that $f_{ce}-f_{emitted}/f_{ce}$ decreases. With each emitted frequency there is associated a stationary wave system making it possible to measure the phase velocity V_ϕ of the waves. This phase velocity is always close to that of the fast electrons accelerated by a potential V. A non-quasistatic formalism for the propagation of waves in a beam-plasma system is then established. The Maxwell equations are solved taking into account boundary conditions. Comparison of these experiments with the theory shows a satisfactory agreement. Author (NSA)

N67-38280 Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
STUDY OF NUCLEAR SEEDED MHD PLASMAS Yearly Summary Technical Report No. 2, 1 May 1966–30 Apr. 1967
William H. Ellis 1 Jun. 1967 198 p refs
(Contract Nonr-580(18))
(AD-657199)

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5. MICROWAVE PLASMA DIAGNOSTIC TECHNIQUES B. E. Mathews and C. A. Langston, Jr. p 177–188 refs (See N67-38285 23-25)

The characteristics of a nuclear seeded plasma for use in a MHD generator are being investigated in four separate areas. In the first, the analytic description of the time-space dependence of a single column of ionization is developed and solved approximately by analytic means. A wide range of dimensionless analytic solutions are presented. In the second area, a numerical approach to the column ionization is developed. The objective is to bypass some of the necessary analytic approximations. In the third area, detailed measurements of the buildup, equilibrium and decay of a helium plasma using neutrons were carried out and are reported for various pressures and He3-CO2 combinations. Finally, an engineering survey calculation was carried out to establish the range of nuclear reactor and engineering parameters appropriate to such a MHD system. Author (TAB)

N67-38281 Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences.
EXPERIMENTAL PLASMA KINETICS
W. H. Ellis, T. E. Albert, and H. G. Cofer *In its* Study of Nucl. Seeded MHD Plasmas 1 Jun. 1967 p 1–81 refs (See N67-38280 23-25)

Measurements were made to determine the mechanisms of plasma production and loss for a helium plasma produced through the slowing down of the products of He^3(n,p)t reaction, and to determine the recombination parameters of such a helium plasma for gas pressures over the pressure range of 1 to 10 atmospheres. A new method for plasma density measurements was developed which has the form of the pulsed ionization chamber. This method was used to study the time dependence of the plasma growth and decay for the above-mentioned gas pressure ranges. Recombination parameters were determined for steady state, growing, and decaying helium plasmas and plasmas produced in gases containing traces of CO_2. From the recombination measurements, the controlling plasma loss mechanism was found to be consistently second order with respect to electron density for all gas filling pressures and conditions examined. Values for the recombination coefficient of He^3 and the He^3–CO_2 mixture were obtained by the method of decay. The CO_2 concentration in He^3 enhanced the magnitude and density of the plasma density. R.N.A.

N67-38282 Florida Univ., Gainesville.
THEORETICAL PLASMA KINETICS
H. E. Wilhelm *In its* Study of Nucl. Seeded MHD Plasmas 1 Jun. 1967 p 82–119 refs (See N67-38280 23-25)

The present state and outcome of theoretical investigations carried through on kinetic theory and statistical mechanics of reacting plasmas is reviewed briefly and its relation to the present experiments explained. A detailed recombination theory is presented for plasma-like media with an inhomogeneous ionization in columns as prevailing in the experiments. The latter theory predicts a recombination rate quantitatively and qualitatively considerably different from ordinary (volume) recombination and seems to be, within its range of applicability, in agreement with latest experimental findings. Author

N67-38283 Florida Univ., Gainesville.
STUDY OF PLASMA HOMOGENIZATION
G. R. Dalton and D. D. Orvis *In its* Study of Nucl. Seeded MHD Plasmas 1 Jun. 1967 p 120–149 refs (See N67-38280 23-25)

To be useful for magnetohydrodynamic power conversion, the plasma generated in the nuclear reactor must be homogeneous. The problem examined is the characteristic time required for randomly oriented and randomly initiated columns to diffuse into a quasi steady state homogeneous plasma. The homogenization time can be determined by examining the temporal behavior of a single column of charge. Intercolumn interaction is small if the ion density is much less than the neutral gas density. The radial distributions of positive ions and electrons about the column center as a function of time after the initial ionization may then be compared with the mean density of ion track production to determine the mean time of homogenization. A numerical solution of the simultaneous nonlinear differential equations of the columnar diffusion problem is described. The columnar diffusion equations were programmed using Fortran IV. R.N.A.

N67-38285 Florida Univ., Gainesville. Dept. of Electrical Engineering.
MICROWAVE PLASMA DIAGNOSTIC TECHNIQUES
B. E. Mathews and C. A. Langston, Jr. *In its* Study of Nucl. Seeded MHD Plasmas 1 Jun. 1967 p 177–188 refs (See N67-38280 23-25)

During this period, efforts were directed toward developing a microwave diagnostic technique which is completely compatible with commerically available ion chambers. The purpose is to obtain an independent measurement which can be compared to the conventional measurement techniques using these chambers. Author

N67-38289# Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires.
CALCULATION OF THE RESONANCE FREQUENCY CHANGE FOR A CAVITY CHARGED BY A PLASMA WITH OR WITHOUT A STATIC MAGNETIC FIELD [CALCUL DU GLISSEMENT DE LA FREQUENCE DE RESONANCE D'UNE CAVITE CHARGEE PAR UN PLASMA EN PRESENCE OU NON D'UN CHAMP MAGNETIQUE STATIQUE]
Gerard Melin Mar. 1967 33 p refs In FRENCH
(CEA-R-3122)

In the case of a cold plasma with or without static magnetic field, two methods are given for calculation of resonance frequency shift and absorption in a cylindrical cavity crossed by a plasma column: (1) a perturbation method, already known and used for electronic density measurements, is restated and its application is used for several high-frequency cavity modes; and (2) an exact method employing Maxwell's equations, which however necessitates a computer, is compared with the first one; it permits a determination of the validity limits of the perturbation method and drawing of conclusions. Author (NSA)

N67-38500# Minnesota Univ., Minneapolis. Dept. of Electrical Engineering.
AFTERGLOW STUDIES IN NITROGEN
Roger E. Lund and Hendrik J. Oskam Jul. 1967 194 p refs
(Contract AF 19(628)-4794)
(AFCRL-67-0423; SR-1; AD-657355)

The temporal behavior of the N(+), N2(+), N3(+) and N4(+) ions in decaying nitrogen plasmas as well as that of the afterglow light intensity was studied in the pressure range of about 0.1 Torr to 1.7 Torr. The plasma container was a glass cylinder covered by a molybdenum film. An electric quadrupole mass spectrometer was used for the ion density studies while a light spectrometer allowed a determination of the spectral distribution of the afterglow light. The analysis of the light intensity decay curves resulted in a method of measuring the surface catalytic efficiency for the recombination of nitrogen atoms at the plasma boundary. An analysis of the N2(+) density decay curves at low pressures revealed that these ions are produced in the afterglow by collisions between metastable molecules N2(x) and N2(y). These metastable molecules are (1) very ineffectively destroyed at the plasma boundary, (b) produced in the afterglow period by the atomic recombination process and (c) responsible for part of the afterglow light emission. The value of the electron temperature, determined through consideration of the losses of the N(+) ions, varied from 1600K to 4500K in the pressure range studied. Evidence was obtained for afterglow electron heating by ionizing collisions between metastable molecules and by superelastic collisions between electrons and vibrationally excited ground state molecules. Author (TAB)

N67-38576# Tennessee Univ., Knoxville.
INSTABILITIES DUE TO ANISOTROPIC VELOCITY DISTRIBUTIONS Progress Report, Sep. 1, 1966–Jun. 1, 1967
Edward G. Harris, Owen C. Eldridge, Ryo Sugihara, and Gary M. Walters 1 Jun. 1967 3 p refs
(Contract AT(40-1)-2598)
(ORO-2598-1) CFSTI: HC $3.00/MF $0.65

Research on plasma instabilities is discussed under the following main topics: kinetic equations, magnetized plasmas, and processes involving photons. NSA

N67-38584# Purdue Univ., Lafayette, Ind. School of Electrical Engineering.
THE RADIATION PRODUCED BY AN ARBITRARILY ORIENTED DIPOLE IN AN INFINITE, HOMOGENEOUS, WARM, ANISOTROPIC PLASMA Final Report
F. V. Schultz and Robert William Graff Dec. 1966 215 p refs
(Contract NOO016-66-C0076-A04)
(TR-EE66-22; AD-652368) CFSTI: HC $3.00/MF $0.65

An expression for the electric field produced by an arbitrarily oriented electric dipole in a warm, anisotropic, single-fluid plasma is derived. The radiation patterns are found for the specific example of a dipole oriented perpendicularly to the externally impressed magnetic field, for a plasma in which omega sub p=0.412 omega, omega sub c=0.75 omega, omega=3x10 to the 8th power radians per second, and U=0.003 c. Results are found to be consistent with previous analyses, yet show significant changes produced by the consideration of electron temperature. Large maxima of radiation were found in the endfire direction, which are not found by the cold-plasma analysis. The procedure of analysis was to reduce the governing equations for this model to a single inhomogeneous wave equation in the electric field intensity, and to subsequently introduce a dyadic Green's function representation for the electric field intensity. The resulting homogeneous equation in the Green's function dyadic, was then Fourier-transformed, and

the alebraic equations produced were then solved for the Green's function dyadic. One can, by a sixfold integration, find the field intensity due to any finite current configuration, using this result.
Author (TAB)

N67-38827# Oak Ridge National Lab., Tenn. Thermonuclear Div.
SOUND WAVES IN PLASMAS: A BASIC PHENOMENON AND A SIMPLE DIAGNOSTIC TOOL
Wm. Denver Jones Jul. 1967 26 p refs
(Contract W-7405-ENG-26)
(ORNL-4089) CFSTI: HC $3.00/MF $0.65

Some experimental aspects of ionic sound waves are discussed. A brief history and discussion is given of some of the more important ionic-sound-wave work. The experiments at the Oak Ridge National Laboratory are discussed in some detail. Note is made of the plasma diagnostic capabilities of these waves.
Author (NSA)

N67-38712*# Yale Univ., New Haven, Conn.
NEGATIVE CYCLOTRON RESONANCE ABSORPTION
Jonathan M. Wachtel (Ph.D. Thesis) 1967 95 p refs
(Grant NGR-07-004-028)
(NASA-CR-89266) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The kinetic theory of waves in an infinite plasma in a uniform constant magnetic field predicts that radiation near the cyclotron frequency in a sufficiently nonthermal plasma may grow in time. One effect which can cause such growth or negative cyclotron resonance absorption of radiation, which propagates perpendicular to the magnetic field direction, is the relativistic energy dependence of the electron's mass. Another is the energy dependence of the electron–atom collision cross section for low energy electrons in a neutral gas background. The cyclotron resonance absorption of microwave energy by monoenergetic electrons that drift through a cavity resonator has been measured in order to verify these predictions. In each case the observed absorption spectra are similar to those calculated in a perturbation theoretical solution of the Boltzmann equation treating the cyclotron resonance interaction between the electron beam and the bounded standing wave fields of the cavity resonator.
Author

N67-38725# Princeton Univ., N. J. Plasma Physics Lab.
PLASMA PHYSICS LABORATORY Annual Report, 1 Jan.–31 Dec. 1966
May 1967 465 p refs
(Contract AT(30-1)-1238)
(MATT-Q-24) CFSTI: HC $3.00/MF $0.65

Articles are presented on experimental stellarator, multipole and Q machine work, equilibrium and stability theory, general plasma theory and engineering developments in magnetic fields, electronic instrumentation, power electronics, power engineering and systems. For individual titles see: N67-38726–38780.

N67-38726# Princeton Univ., N. J. Plasma Physics Lab.
ALKALI PLASMA EXPERIMENTS IN THE C STELLARATOR
W. Stodiek, D. J. Grove, G. Hsi, E. B. Meservey, and M. G. Rusbridge *In its* Plasma Phys. Lab. May 1967 p 1–19 refs (See N67-38725 23-25)

In the dynamic and steady state experiments on alkali metals (potassium and cesium), contact ionization was used to form the plasma rather than applied electric fields. For the dynamic experiments, the plasma is formed on a hot filament which is subsequently withdrawn; after the filament is out, the residual plasma is studied. The results show that contact ionization does not change the basic picture of particle containment in the C stellarator. The loss rate is not classical; instead, the data agree within a factor of 2 or 3 with the behavior predicted by extrapolation from the usual hydrogen discharges, which have higher temperature and density. For the steady state experiments, the plasma is formed on a hot sphere which remains at the center of the aperture while measurements are made. The observations support the dynamic experiments and are consistent with earlier work on hydrogen afterglow plasmas, which indicates an anomalous loss roughly given by Bohm diffusion.
M.G.J.

N67-38727# Princeton Univ., N. J. Plasma Physics Lab.
INVESTIGATIONS OF PLASMA EXPANSION WITH AN EXPANDING LIMITER
W. Stodiek, D. J. Grove, and C. G. Hsi *In its* Plasma Phys. Lab. May 1967 p 20–42 refs (See N67-38725 23-25)

An expanding limiter was devised to study the behavior of a hydrogen afterglow plasma column when it is free of a limiting metallic boundary. The limiter consists of four titanium leaves through which pulsed currents up to 250 amperes can be passed, flowing along the channels defined by the two slits in the leaves. Interest centered on determining the rate of expansion of the toroidal plasma when the boundary is suddenly removed, and on whether the motion is predominantly in one direction. Preliminary results indicate that a variable aperture limiter can be made to double the aperture in times comparable to plasma decay times. Under these conditions the plasma seems to expand roughly uniformly.
M.G.J.

N67-38728# Princeton Univ., N. J. Plasma Physics Lab.
RADIAL DEPENDENCE OF THE DIFFUSION COEFFICIENT FOR OHMIC-HEATED PLASMAS IN THE MODEL C STELLARATOR
A. Haberstich *In its* Plasma Phys. Lab. May 1967 p 43–52 refs (See N67-38725 23-25)
(Grant NSF GP-579)

Consideration is given to diffusion, absorption, and ionization coefficients which have different values in different regions, and which are temperature- and time-dependent as well. For the ordinary ohmic heating regime, a steady state solution of the continuity equation for a cylindrically symmetric discharge was adopted. Taking ionization and local variations of temperature into account and assuming a very simple division into inner and outer regions, a diffusion coefficient of 3 to 5 times the Bohm value is found for the inner region of the discharge. The outer coefficient remains markedly smaller. The flux to the divertor is 1.2 to 1.5 times the ion saturation current. The case of the ohmically heated plasma, rotating under the influence of a pulsed radial electric field, was treated time-dependently to determine transient effects. It was found that application of a pulsed radial electric field reduces the diffusion coefficient in the biased region by a factor of 7, and improves the confinement time by a factor of 2.
M.G.J.

N67-38729# Princeton Univ., N. J. Plasma Physics Lab.
OBSERVATIONS ON A ROTATING TOROIDAL PLASMA
E. C. Tanner and J. G. Gorman *In its* Plasma Phys. Lab. May 1967 p 53–59 refs (See N67-38725 23-25)

The variation of confinement times as a function of rotation is discussed in relation to experimental data which show that although plasma column rotation at moderate velocites improves confinement, velocity increases beyond some critical values often result in a decrease of confinement time toward its original value. It is pointed out that rotation results when a large Langmuir probe, positively or negatively biased up to a few hundred volts, is located about half-way into the discharge column. Observations on velocity shear, noise measurements, and instability are presented. It was found that the activation of two probes, the second at a larger radius and a lower bias than the first, causes the density steps to disappear. Results indicate that the use of two biased probes apparently enhance the benefits due to rotation: the observed confinement times can be increased approximately 50% above the maximum attainable with only one biased probe.
M.G.J.

N67-38730# Princeton Univ., N. J. Plasma Physics Lab.
ION VISCOUS STABILIZATION OF A STELLARATOR PLASMA
R. A. Ellis, Jr., K. Bol, and T. H. Stix *In its* Plasma Phys. Lab. May 1967 p 60–64 refs (See N67-38725 23-25)

Experiments were conducted on afterglow discharges in the Etude stellarator at magnetic fields of 1 to 4 kilogauss to investigate the large-λ regime. Discharges were produced in several gases by a 10.5 GHz, 20 kw oscillator; for gas pressures in the range 0.08 to 0.1 millitorr, typical values for density and electron temperature were $3\times10^{12}cm^{-3}$ and 15 eV, respectively. For each gas the electron temperature, determined by the Langmuir probe, fell to 1 to 2 eV within 500 μsec after the microwave power was turned off, then decayed more slowly. The radial distributions of ion saturation current fell, in a more or less Gaussian manner, to values at the edge of the magnetic aperture (3 cm radius) equal to about 10% of their on-axis maxima. Figures depict a series of multiple traces of ion saturation current versus time for krypton afterglows. It is noted that for magnetic fields greater than some critical value the traces are no longer reproducible. The onset of nonreproducible fluctuations is interpreted as a measure of instability growth rate. Author

N67-38731# Princeton Univ., N. J. Plasma Physics Lab.
DAMPING OF THE FAST HYDROMAGNETIC WAVE
M. A. Rothman *In its* Plasma Phys. Lab. May 1967 p 68–70 refs (See N67-38725 23-25)
(Grant NSF GP-579)

Based on the assumption of a uniform plasma with a sharp boundary, calculations are presented on the total damping length obtained by summing three energy absorption mechanisms and integrating over the cross sectional areas of the plasma. These mechanisms are: the body wave described by the electric field distribution; the surface mode allowed by the dispersion relation; and Landau damping. The surface wave gives a very thin layer at the surface of the plasma, with E_z fields an order of magnitude greater than in the body of the plasma. Results show that both Landau and resistive damping are greatly enhanced. M.G.J.

N67-38732# Princeton Univ., N. J. Plasma Physics Lab.
PLASMA PRODUCTION AND FLUCTUATION MEASUREMENT IN A LINEAR QUADRUPOLE DEVICE
D. Meade and S. Yoshikawa *In its* Plasma Phys. Lab. May 1967 p 71–87 refs (See N67-38725 23-25)
(Grant NSF GP-579)

To show that shortening in the mean free path does not bring about fluctuations, experiments were conducted in a minimum average-B device in which the density was kept relatively high ($n=10^{10}$–10^{12}) and both electron and ion temperatures were kept low. Thus the mean free path was kept comparable with the characteristic length. A cylindrical vacuum vessel with two center conductor bundles to form a quadrupole magnetic was used with an air-core, 15-turn coil placed inside the vessel to heat the plasma inductively. Plasma production and heating methods are described, and data are presented on the density profile, fluctuations, and loss process. It is shown that a plasma of $10^{12}cm^{-3}$ density can be produced by rf heating in a linear multipole device, and that the plasma decays with the time constant of 2 to 10 msec in the late afterglow. Fluctuations are large in the unstable region and small in the stable region. It is also noted that the ratio of plasma radius to ion Larmor radius, and the plasma dielectric constant, are much larger than those obtained previously. M.G.J.

N67-38733# Princeton Univ., N. J. Plasma Physics Lab.
FLUCTUATION MEASUREMENTS IN A LINEAR QUADRUPOLE DEVICE
M. G. Rusbridge and E. B. Meservey *In its* Plasma Phys. Lab. May 1967 p 98–100 refs (See N67-38725 23-25)
(Grant NSF GP-579)

A long period integrator was used to measure the rms amplitude and correlation functions of fluctuations observed in the linear quadrupole device. The fluctuating signals, representing ion saturation current or floating potential, were obtained from two probes. The preliminary results indicate: (1) The afterglow in helium lasts for about 15 msec after the heating power is turned off. The decay of the plasma is partly due to recombination; the drift towards the end of the machine is very slow. The dominant fluctuations are clearly flutes which occur outside the critical surface and are well correlated along the lines of force. Their properties can be described qualitatively by a model including both finite Larmor radius effects and ion-neutral collisions. Quantitatively, the agreement is better than an order of magnitude. (2) The microwave heating pulse lasted for some 6 msec, with conditions sensibly constant over the last 4 msec. Fluctuations invade the magnetohydrodynamic stable region, reaching as far as halfway to the separatrix. M.G.J.

N67-38734# Princeton Univ., N. J. Plasma Physics Lab.
INSTABILITY AT LOW PLASMA DENSITY IN A WEAK MAGNETIC FIELD TOROIDAL MULTIPOLE (MINIPOLE)
D. M. Meade, R. Palladino, and S. Yoshikawa *In its* Plasma Phys. Lab. May 1967 p 101–106 refs (See N67-38725 23-25)
(Grant NSF GP-579)

A vertically stacked toroidal quadrupole device, with the internal coil current less than or equal to 5 kiloamperes in each conductor, was constructed to investigate the instability. Of particular interest were the reported data that fluctuations are present in a low density plasma confined by a toroidal quadrupole, but the same plasma in a toroidal octupole of comparable size is quiescent. To produce the plasma, an rf discharge at ≈200 kc was first initiated at a filling pressure of about 1μ of hydrogen at the center of the inner coils with only the external coils energized. A current pulser with a flat top of ≈1 msec was used to energize the 10-turn inner coils through coaxial leads. The ion saturation current profile in the horizontal median plane was measured by a single Langmuir probe, and oscilloscope traces of the ion saturation current as observed by the probe are included. The results suggest that the fluctuations observed may not necessarily be harmful, as they disappear with an increase in density. M.G.J.

N67-38735# Princeton Univ., N. J. Plasma Physics Lab.
SHEAR STABILIZATION OF A POTASSIUM PLASMA
F. Chen and D. Mosher *In its* Plasma Phys. Lab. May 1967 p 107–113 refs (See N67-38725 23-25)

To suppress resistive and universal instabilities harmful to plasma confinement, an experiment was designed to test the use of large shear in the absence of magnetic wells with min-B, and without shortening the connection length between regions of good and bad curvature. Data are presented on the radial profiles of ion saturation probe current for various values of shear current in the axial conductor; the variation of the normalized diffusion coefficient with shear parameter for three values of total input flux; and x–y recorder traces of the radial profiles of density and mean square oscillation amplitude for different shear currents. The results show that shear alone can greatly reduce the anomalous loss rate in a resistive plasma; its effectiveness apparently comes from the localization of ordinary normal modes. However, the amount of shear required is rather large, and it may be more efficient to use magnetic wells or shortened connection lengths to eliminate drift modes. M.G.J.

N67-38736# Princeton Univ., N. J. Plasma Physics Lab.
COLLISIONAL DRIFT WAVE IN NONISOTHERMAL PLASMAS
H. W. Hendel and P. A. Politzer *In its* Plasma Phys. Lab. May 1967 p 114–129 refs (See N67-38725 23-25)

Details are given on an experiment undertaken to identify the collisional drift wave in alkali plasmas. The plasma consists of

ions produced by surface ionization of cesium or potassium atomic beams incident on hot tungsten plates, and of thermionic electrons emitted from the same plates. Coherent, almost sinusoidal, oscillations were observed over a wide range of experimental parameters—densities from 5×10^{10} to 5×10^{12} cm^{-3}, plasma temperatures from 2300° to the upper limit of approximately 2900°K, and magnetic field strengths from 2000 to 6500 gauss. Measurements of azimuthal propagation velocity are reported, with plasma rotation due to the radial electric field considered. Mode stabilization phenomena are described. The presence of collisional drift waves in alkali plasmas is demonstrated. For given parameters a single mode predominates, but transitions occur from one dominant mode to another when magnetic field, plasma density, plasma temperature, or ion mass is varied, in agreement with the theory. M.G.J.

N67-38737# Princeton Univ., N. J. Plasma Physics Lab.
RADIATION STUDIES IN A CESIUM PLASMA
R. W. Motley and J. Marsh *In its* Plasma Phys. Lab. May 1967 p 130–140 refs (See N67-38725 23-25)
(Grant NSF GP-579)

In the experiment described, a microwave receiving antenna was placed at the center of a cesium plasma column to measure radiation near the electron plasma frequency. The dipole antenna was connected through a coaxial line to a superheterodyne receiver, which could be tuned between 4000 and 8000 Mc; a Dicke radiometer was used to improve the noise figure of the receiver. At low density, only a small noise signal was detected; as plasma density increased there was a sudden onset of noise which occurred when the plasma frequency became roughly equal to the receiver frequency. With further increase in density, the noise power rose to a peak, then fell 20% to 30% and, finally, increased again at very high densities. Attention was also focused on that region of the spectrum where there is no change in plasma equilibrium. The radiation in this spectral interval appears to be confined within the plasma column; the intensity drops rapidly as the antenna is moved radially out of the plasma column. A simple equilibrium model to predict microwave intensity is discussed briefly. M.G.J.

N67-38738# Princeton Univ., N. J. Plasma Physics Lab.
DIRECT MEASUREMENT OF THE CONFINEMENT TIME OF CESIUM PLASMA IN A Q DEVICE
S. von Goeler and R. W. Motley *In its* Plasma Phys. Lab. May 1967 p 142–147 refs (See N67-38725 23-25)

In the experiment described, the plasma is allowed to attain a steady state, then the atomic beam producing the plasma at one end of the column is mechanically interrupted. It is postulated that if the subsequent decay time of the plasma is much longer than the time of sound wave propagation between the end plates, a quasi-steady state with little density variation along the field lines should exist. Thus, a measurement at one position along the field is representative of the whole column and should reflect the main loss mechanism. The confinement time versus plasma density for four plate temperatures is examined. Generally, it was found that confinement time (1) does not depend sensitively on the plasma density; (2) exhibits almost no magnetic field dependence if the gyration radius is much smaller than the column radius; and (3) shows no marked dependence on plate power, which is seen in the equilibrium region. M.G.J.

N67-38739# Princeton Univ., N. J. Plasma Physics Lab.
ION TEMPERATURE IN A PLASMA PRODUCED BY CONTACT IONIZATION
J. G. Hirschberg, J. E. Hesser, E. Hinnov, and N. Rynn *In its* Plasma Phys. Lab. May 1967 p 148–154 refs (See N67-38725 23-25)

Ion and electron temperature measurements are reported for different densities in barium plasmas and in cesium–barium mixtures. The temperatures were determined from the Doppler widths of either the σ or the π components of the λ 4934, $6^2S_{1/2}$–$6^2P_{1/2}$ of Ba^+, observed at right angles to the confining field approximately halfway between the rhenium end plates. The results show: (1) Ion temperatures are much higher than electron temperatures at lower densities, and decrease with increasing plasma densities. (2) As cesium is added, the ion temperatures are further increased and require higher densities to bring them into agreement with the electron temperatures. Considered significant is the rise of the electron temperature (by about 900°K) which is apparently independent of the relative proportion of cesium and barium except for a probable threshold concentration of cesium. In examining the effect of an externally imposed current on a pure barium plasma, it was found that at small negative currents ion temperature and density increase slightly, and then drop rapidly with increasing current. M.G.J.

N67-38740# Princeton Univ., N. J. Plasma Physics Lab.
THERMALLY IONIZED ALKALI PLASMAS WITH NEGATIVE IONS
N. D'Angelo, T. Ohe, and S. von Goeler *In its* Plasma Phys. Lab. May 1967 p 155–163 refs (See N67-38725 23-25)

The diagnostic techniques used to obtain quantitative measurements of the negative ion density are described. These include a microwave interferometer for electron density, and a mass spectrometer for negative ion density measurements. Positive ion density was determined by Langmuir probes and from the ion flux to the slightly negatively-biased shield of the mass spectrometer. Data are presented on the ratio of negative ion density to positive ion density versus flux for a CsCl molecular beam on a tungsten plate, and for a KCl molecular beam on a niobium plate for different heating powers of the plate. Experimental results are compared with theory. In the case of CsCl and tungsten plates, negative ion densities more than ten times higher than theoretical predictions were found. The theory and experimental data were in agreement for the case of KCl with niobium end plates. M.G.J.

N67-38741# Princeton, Univ., N. J. Plasma Physics Lab.
PRODUCTION OF QUIESCENT DISCHARGE WITH HIGH ELECTRON TEMPERATURES
G. Lisitano, R. A. Ellis, Jr., W. M. Hooke, and T. H. Stix *In its* Plasma Phys. Lab. May 1967 p 164–173 refs (See N67-38725 23-25)

A technique is described for applying radio frequency (RF) power to a coupling structure to generate collisionless steady state plasmas in a mirror-geometry magnetic field. The RF device is a slotted metal tube connected to a waveguide or transmission line. The axial slots are spaced uniformly around the circumference; short azimuthal slots connect alternate ends of the axial slots. The vacuum system and magnetic field coils are depicted. The magnetic field configuration has a mirror ratio of 2.6:1, and a maximum mirror field of 2.3 kilogauss. Characteristic times and lengths for typical plasmas produced by this method are tabulated. In the quiescent plasmas produced, the observed ratio of rms fluctuations with frequencies below 500 kHz to average ion saturation current is 0.01 to 0.02 in hydrogen and xenon discharges. The same level of low frequency fluctuations is also observed for floating potential fluctuations. M.G.J.

N67-38742# Princeton, Univ., N. J. Plasma Physics Lab.
ENHANCED RADIATION FROM NONTHERMAL ELECTRONS IN A DENSE MAGNETIZED PLASMA
R. A. Blanken and A. F. Kuckes *In its* Plasma Phys. Lab. May 1967 p 174–183 refs (See N67-38725 23-25)

Observational details are reported on greatly enhanced radiation in two distinct frequency ranges associated with second harmonic cyclotron frequencies of the relativistic nonthermal component and the dense nonrelativistic component. An energetic nonthermal component is considered present for both types of radiation

observations. The electron-cyclotron resonance heating device used is described. The results show: (1) Radiation is due to the excitation of the lowest electrostatic resonances of a warm, dense, magnetized plasma by relativistic nonthermal electrons. For the relativistic nonthermal component, the upper hybrid resonance provides the necessary dielectric constant; for the dense nonrelativistic component, it is the lowest Bernstein mode. (2) In both cases, the emission increases more rapidly than the number of nonthermal electrons, so that any single-particle picture of the excitation is ruled out. (3) Apparently, radiation is caused by instabilities due to nonthermal electron interaction with warm, dense plasma. M.G.J.

N67-38743# Princeton, Univ., N. J. Plasma Physics Lab.
PLASMA INJECTION BY LITHIUM SPARK
G. Mehlman *In its* Plasma Phys. Lab. May 1967 p 185–186 refs (See N67-38725 23-25)

Preliminary data are presented on efforts to produce high purity plasma with a low recycling rate, by introducing lithium plasma into a stellarator. This is done by using a fast, high intensity discharge of a condenser between a lithium anode and the walls of the vacuum vessel. Spectroscopic and spectrographic measurements demonstrate that the Li II line intensity was much greater with the magnetic field, and more uniform along the lithium anode. Half-widths of the lithium lines were also measured on the densitometer traces of the spectra. The Li II line exhibits an almost symmetrical profile, the electrons being essentially responsible for its broadening, as theory predicts, at such temperatures and densities. M.G.J.

N67-38744# Princeton Univ., N. J. Plasma Physics Lab.
ELECTRICAL CONDUCTIVITY OF A PARTIALLY IONIZED GAS
L. C. Johnson *In its* Plasma Phys. Lab. May 1967 p 187–191 refs (See N67-38725 23-25)

Equations are formulated to express the results of a numerical solution to the Boltzmann–Fokker–Planck equation for a partially ionized gas in a weak, steady electric field. A variety of electron–molecule collision frequencies is assumed. Factors for determining the electrical conductivity of a partially ionized gas are tabulated. A figure for use with this table is included to show the velocities at which collision frequencies of the gases are to be evaluated. A procedure is outlined for obtaining a reliable estimate of the conductivity of the gas; only a few iterations are required. It is pointed out that the accuracy of the result is usually limited by the imprecise knowledge of electron and neutral concentrations and momentum transfer cross sections, rather than by the approximations associated with the procedure. M.G.J.

N67-38745# Princeton Univ., N. J. Plasma Physics Lab.
NONEQUILIBRIUM EXCITATION OF NEUTRAL HELIUM IN PLASMAS OF MODERATE DENSITY
L. C. Johnson *In its* Plasma Phys. Lab. May 1967 p 192–193 refs (See N67-38725 23-25)

The principal results of an excitation phenomena analysis are presented. These include: (1) The large population densities of excited states in ohmic heating discharges, with respect to Saha equilibrium, can be quantitatively accounted for by collisional and radiative transitions. (2) Cross sections for $n \rightarrow n'$ transitions, with $n'>n>2$, cannot differ near threshold by more than a factor of about 1/3 from a (ln U)/U function, scaled according to the Bethe approximation, where U is the ratio of the incident electron energy to the excitation energy. (3) The observed population densities of $n=3$ triplet states relative to those of higher triplet states can be reproduced by reducing the collisional rates for $n=2 \rightarrow n=3$ transitions while other transition rates are left unchanged. (4) The calculated population densities of singlet states are sensitive to moderate changes in the assumed cross sections for $1^1S \rightarrow n^1P$ transitions. Author

N67-38746# Princeton Univ., N. J. Plasma Physics Lab.
INTERCHANGE INSTABILITIES AND GEODESIC CURVATURE
J. M. Greene and J. L. Johnson *In its* Plasma Phys. Lab. May 1967 p 212–216 refs (See N67-38725 23-25)

The importance of forces associated with the geodesic curvature of magnetic field lines is discussed in relation to three separate stability studies. In an ideal hydromagnetic model, the energy principle was used to study instabilities. Equations are derived which lead to a localized, divergence-free perturbation in which the component normal to the magnetic surface is small with respect to the component in the surface. This latter component has some variation along the field lines so as to remove energy from the geodesic curvature term as well as minimize that associated with the residual shear. A simplified resistive model is described in which motion along the field lines is ignored. Also mentioned is a realistic resistive model in which the full set of fluid equations is used for the calculations. M.G.J.

N67-38747# Princeton Univ., N. J. Plasma Physics Lab.
A VARIATIONAL PRINCIPLE FOR STATIONARY MAGNETOHYDRODYNAMIC EQUILIBRIA
J. M. Greene and E. T. Karlson *In its* Plasma Phys. Lab. May 1967 p 221–223 refs (See N67-38725 23-25)

Equations are derived and a variational principle is developed for stationary, bounded, magnetohydrodynamic flow in the absence of any source of dissipation. Constraints are introduced to define the potential and restrict the choice of the other variables. This variational principle shows that it is necessary to prescribe five functions of the magnetic, or potential, surfaces in order to give a well-posed problem. It is pointed out that the steady state equations are not completely elliptic and have a number of real characteristics; their effect on the utility of the variational principle has not been determined. M.G.J.

N67-38748# Princeton Univ., N. J. Plasma Physics Lab.
ENERGY-VARIATIONAL PRINCIPLES FOR STEADY HYDROMAGNETIC FLOWS IN A TOROID
M. D. Kruskal and C. H. Su *In its* Plasma Phys. Lab. May 1967 p 224–228 refs (See N67-38725 23-25)

A complete set of constants of motion is obtained, and the variational principle for general stationary flows is formulated. The null displacement condition is applied to the state functions of density, specific entropy, magnetic field, and velocity to derive the conditions, which any virtual displacement of fluid elements that leaves the state functions invariant, must satisfy. A kinematically steady state is defined as one which satisfies the kinematic conditions but not necessarily the dynamical equation. It is pointed out that variational principles have value because they indicate what conditions beyond the steady-state differential equations are needed to specify a steady state uniquely. In the case presented, it is considered plausible that there is one, and only one, stationary hydromagnetic flow for each choice of the quintuple of functions, and that these functions may be thought of as coordinates for the space of steady states. M.G.J.

N67-38749# Princeton Univ., N. J. Plasma Physics Lab.
RELATION BETWEEN THE GREENE–KARLSON AND THE ENERGY-VARIATIONAL PRINCIPLES FOR STEADY IDEAL HYDROMAGNETIC TOROIDAL FLOWS
M. D. Kruskal and C. H. Su *In its* Plasma Phys. Lab. May 1967 p 229–231 ref (See N67-38725 23-25)

A redefinition is presented on an energy variational principle. It is shown that a kinematically steady state makes the Lagrangian variationally stationary with certain constraints if, and only if, it satisfies the dynamical equation; this is the Greene and Karlson principle. M.G.J.

N67-38750# Princeton Univ., N. J. Plasma Physics Lab.
EQUILIBRIUM AND STABILITY IN GENERAL GEOMETRY
P. H. Rutherford and E. A. Frieman *In its* Plasma Phys. Lab. May 1967 p 232–235 refs (See N67-38725 23-25)

Equilibrium and stability of collisionless plasma are considered for the case where the field lines are all closed; the ratio of plasma to magnetic pressure is assumed to be so small that all perturbations in the magnetic field may be neglected; and the electric field may be taken to be irrotational. The Vlasov–Poisson equations are solved by expansion in ϵ, the ratio of the Larmor radius to a macroscopic length scale, a fundamental small parameter of the theory. Criteria are derived in terms of the functional dependence of the equilibrium distribution function on the adiabatic invariants of the particle motion. A formula is also given for extending the results to cases where there is a lowest-order configuration with closed field lines, together with a small shear field which opens the field lines and creates magnetic surfaces. M.G.J.

N67-38751# Princeton Univ., N. J. Plasma Physics Lab.
GUIDING-CENTER DRIFTS IN THE STELLARATOR
C. G. Smith *In its* Plasma Phys. Lab. May 1967 p 236–242 refs (See N67-38725 23-25)

To determine the role of the helical structure, the guiding center equations were integrated asymptotically for an $l=2$ stellarator configuration. To a first approximation the field is constant, but as the line of force is rotated about the magnetic axis (from outside to inside) field strength increases due to the toroidal geometry. The introduction of the helical winding, which produces this rotation, causes a short-wavelength oscillation in field strength. Formulas expressing the magnitudes of these variations are given. Only transit particles are considered, and it is shown that particles with very large parallel velocities hardly feel the perturbations; those with modest velocity get through many helical field periods and then mirror towards the inside. In theory, the stellarator provides an absolute plasma trap since the particle trajectory in the cross-sectional plane is a closed surface, displaced a finite amount from a magnetic surface. Numerically, the displacement may be significant relative to the bounding walls of the vacuum vessel, and may affect stability. M.G.J.

N67-38752# Princeton Univ., N. J. Plasma Physics Lab.
STABLIZATION OF THE RESISTIVE BALLOONING MODE BY SOUND WAVES
R. M. Kulsrud *In its* Plasma Phys. Lab. May 1967 p 246–250 refs (See N67-38725 23-25)

Pressure nonequilibrium induced along the magnetic curvature lines in a stellarator by the resistive ballooning mode can be stabilized through introduction of sufficiently large sound waves damped by viscosity. In the collision dominated limit and in the absence of shear, the pressure nonequilibrium induced along curvature lines by the resistive ballooning mode must relax in a shorter time period than the perturbation folding time. As shear increases, perpendicular viscosity has to be considered. G.G.

N67-38753# Princeton Univ., N. J. Plasma Physics Lab.
EXCITATION OF LONGITUDINAL WAVES BY A GRID
D. Dobrott and H. Weitzner (N. Y. Univ.) *In its* Plasma Phys. Lab. May 1967 p 261–265 refs (See N67-38725 23-25)

Excitation of a Vlasov plasma at a grid was analyzed by applying the mixed initial-value boundary problem to plasmas consisting of electrons and a background of fixed ions. Secondary data were quite general and the unperturbed velocity distribution function was taken as a monotonically decreasing function of energy. The result has a time dependence and is characterized as possessing an analytic continuation into the upper half-plane of the complex frequency. Error estimates, which determine the range of wave observability, are given for Debye schielding, exponentially damped ion-acoustic waves, exponentially damped ion plasma oscillations, exponentially damped ion waves, and exponentially damped electron oscillations. G.G.

N67-38754# Princeton Univ., N. J. Plasma Physics Lab.
A ONE-DIMENSIONAL PLASMA MODEL INCLUDING RADIATION
J. M. Dawson and A. B. Langdon *In its* Plasma Phys. Lab. May 1967 p 274–278 refs (See N67-38725 23-25)
(Contract AF 49(638)-1555; Grant NSF GP-579)

A plasma sheet model was constructed that allows for two-dimensional motions in the x and y direction in such a way that the sheets remain perpendicular to the x direction as they pass freely through each other. Motion of the sheets in the transverse y direction induced transverse electric and magnetic fields. Some preliminary results for radiation emitted by the field generated just above cyclotron frequency showed peaks around the hybrid frequency. Radiation emitted just above the cyclotron frequency was attributed to particles near the boundary of the plasma moving in and out of the plasma. G.G.

N67-38755# Princeton Univ., N. J. Plasma Physics Lab.
EXACT STATISTICAL MECHANICS OF A ONE-DIMENSIONAL PLASMA MODEL. PART I: NONNEUTRAL PLASMA
D. S. Wiley *In its* Plasma Phys. Lab. May 1967 p 279–285 refs (See N67-38725 23-25)
(Contract AF 49(638)-1555)

Discussed are the exact statistical mechanics of the one-dimensional model for a non-neutral plasma. The model allows velocity components in the plane of the sheets perpendicular to the x axis and assumes both positively charged and negatively charged sheets. The electrostatic force between the sheets is of long range, and the self-magnetic interaction resulting from perpendicular motion is neglected in calculating the thermodynamic behavior of the system. G.G.

N67-38756# Princeton Univ., N. J. Plasma Physics Lab.
EXACT STATISTICAL MECHANICS OF A ONE-DIMENSIONAL PLASMA MODEL. PART II: INFLUENCE OF EXTERNAL FIELDS
D. S. Wiley *In its* Plasma Phys. Lab. May 1967 p 286–291 refs (See N67-38725 23-25)
(Contract AF 49(638)-1555)

Details are given for the exact statistical mechanics of a one-dimensional model of a cusped plasma device whose particles have a fixed magnetic moment under the influence of a constant electric field and a spatially varying magnetic field. The basic one-dimensional sheet plasma is assumed to have a fixed magnetic moment depending on the charge sign of the sheet; the linearly varying magnetic field produces gyrations about the x axis of decreasing radius. If pressure constraints the system to a finite volume, some of the properties of a cusped plasma are simulated. The perpendicular and the uncoupled motion along its x axis are described by different temperatures and the Hamiltonian is written in terms of charge configuration parameters. G.G.

N67-38757# Princeton Univ., N. J. Plasma Physics Lab.
THE STATISTICAL MECHANICS OF A RELATIVISTIC ONE-DIMENSIONAL PLASMA MODEL WITH COULOMB AND SELF-CONSISTENT MAGNETIC FORCES
D. S. Wiley *In its* Plasma Phys. Lab. May 1967 p 292–299 refs (See N67-38725 23-25)
(Contract AF 49(638)-1555)

Investigated are the equilibrium statistical mechanics of a neutral plasma consisting of positively and negatively charged sheets in the y–z plane that are constraint perpendicular to the x axis, have a velocity in the y direction, and generate a self-consisting magnetic field in the z direction. A quasi-static Darwin Hamiltonian that includes electric, magnetic, and kinematic effects is formed. G.G.

N67-38758# Princeton Univ., N. J. Plasma Physics Lab.
ASYMPTOTIC EVALUATION OF A CLASS OF COUPLED MULTIPLE INTEGRALS WHOSE INTEGRAND DEPENDS ON EXP[$-\alpha x^4-\beta x^2-\gamma x$]
D. S. Wiley *In its* Plasma Phys. Lab. May 1967 p 300–303 ref (See N67-38225 23-25)
(Contract AF 49(638)-1555)

In various problems in statistical mechanics in which the Hamiltonian contains an x^4 term, one is required to evaluate complex integrals in which a symmetric matrix contains elements that are independent. The integrals cannot be performed in close form; however, in many applications the parameter is much smaller than the diagonal elements of the matrix. It is the purpose of the present work to exhibit an asymptotic expansion of these complex integrals. Author

N67-38759# Princeton Univ., N. J. Plasma Physics Lab.
CONSERVATION LAWS FOR THE KORTEWEG–deVRIES EQUATION AND ITS GENERALIZATIONS
M. D. Kruskal, R. M. Miura, C. S. Gardner, and N. J. Zabusky (Bell Telephone Labs., Inc., N. Y.) *In its* Plasma Phys. Lab. May 1967 p 315–320 refs (See N67-38725 23-25)

It is shown that the Korteweg–deVries (KdV) equation possesses a tenth conservation law of the form $\delta T/\delta t + \delta X/\delta x = 0$ where T and X are finite polynomials in u and its x derivatives. It is proven that the only polynomial conserved density of rank r for the equation $\delta u/\delta t + u\delta u/\delta x = 0$ is u^r independent of the derivatives of u_0. Thus, if a $T^{(r)}$ exists for the KdV equation, then it must contain u^r with nonvanishing coefficient. G.G.

N67-38760# Princeton Univ., N. J. Plasma Physics Lab.
DERIVATION AND PROPERTIES OF THE ASYMPTOTIC LIMIT OF THE KORTEWEG–deVRIES EQUATION FOR VANISHING COEFFICIENT
R. M. Miura, M. D. Kruskal, and N. J. Zabusky (Bell Telephone Labs., Inc., N. Y.) *In its* Plasma Phys. Lab. May 1967 p 321–328 refs (See N67-38725 23-25)
(Contract AF 49(638)-1555)

Observations of finite-amplitude solutions for the Korteweg–deVries equation for vanishing coefficient showed that finitely varying initial data soon developed oscillations with period of order δ. A two scale formalism in which the oscillatory solution was characterized by finitely varying functions of x and t was used to determine the new dependent variable U periodic in an additional phase-angle variable. Integration of the modified equation gave the detailed structure of the oscillations for given local values of the finitely varying variables. G.G.

N67-38761# Princeton Univ., N. J. Plasma Physics Lab.
DERIVATION OF THE KORTEWEG–DE VRIES EQUATION
C. S. Gardner and C. H. Su *In its* Plasma Phys. Lab. May 1967 p 329–331 ref (See N67-38725 23-25)
(Contract AF 49(638)-1555)

The Korteweg–deVries equation is derived for the following nonlinear dispersive systems: (1) Boussinesq equation for water waves; (2) collision-free hydromagnetic waves; and (3) ion-acoustic waves. The equations are simplified by denoting the amplitude of the disturbances and using constants to characterize the different physical systems. G.G.

N67-38762# Princeton Univ., N. J. Plasma Physics Lab.
THE KORTEWEG–DE VRIES EQUATION AS A HAMILTONIAN SYSTEM
C. S. Gardner *In its* Plasma Phys. Lab. May 1967 p 332–333 (See N67-38725 23-25)
(Contract AF 49(638)-1555)

The Korteweg–de Vries partial differential equation derivable from the variational principle is shown to take the Hamiltonian form by introducing the Fourier representation and assuming periodicity. Results of interest associated with the mathematical development are identified. E.E.B.

N67-38782# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SPECTROSCOPIC INVESTIGATIONS OF PLASMA IN A MAGNETO-HYDRODYNAMIC SHOCK-TUBE [SPEKTROSKOPICHESKIYE ISSLEDOVANIYA PLAZMY V MAGNITOGIDRODINAMISCHESKOY UDARNOY TRUBE]
Yu. V. Mararov and A. M. Maksimov *In its* Phys. Gas Dyn., Heat Transfer and Thermodyn. of High Temp. Gases (Selected Articles) 20 Jan. 1967 p 1–8 refs (See N67-38781 23-12)

A 3-prism glass spectrometer was set up 90 cm from the ring electrode. The speed of the shock-front was measured by an arrangement of photomultipliers which detected the front of the shock wave. The typical spectrum shows a continuous background, more intense at the red end with some broad and narrow lines. The spectrum was analyzed by comparison with mercury and iron spectra. Bright lines were obtained from the copper electrodes and the gydrogen Balmer series, and thus indicated the temperature and ion concentration of the plasma. Changes in the spectra when the discharge parameters were changed are then discussed. The ion concentration for various pressures and velocities was obtained from Stark broadening. Subsidiary experiments showed a rapid growth in intensity and the presence of high temperature zones behind the luminescent front. The temperature and ion concentration decreased at high pressures. Author

N67-38817# Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires.
SCATTERING OF ELECTROMAGNETIC WAVES BY NON-UNIFORM CYLINDRICAL PLASMA [DIFFUSION COHERENTE D'UNE ONDE ELECTROMAGNETIQUE PAR UN CYLINDRE DE PLASMA INHOMOGENE]
Paul Etienne Faugeras (Ph.D. Thesis—Paris Univ., Orsay, France, 7 Dec. 1966) 1967 99 p refs In FRENCH
(CEA-R-3133)

The problem of the scattering of plane electromagnetic waves from a nonuniform, cylindrically symmetrical plasma is solved analytically, by a self-consistent field method, for a wave with the electric field parallel to the cylinder axis. Numerical results for the diffracted field are plotted for interesting ranges of the parameters involved: diameter, density on the axis, radial profile of the density, and collision frequencies. The case where the incident field is cylindric (waves surfaces parallel to the cylinder axis) is examined: this permits to connect theoretical calculations and experimental diffraction patterns, and also to explain the diffraction effects observed in a classical microwave interferometry experiment. These results, and the possibility of measuring exactly the diffracted field (showed by experiments with dielectric and metallic rods) lead to a new plasma diagnostic method, based on the diffraction, which has no theoretical limitations and is usable when the classical free-space wave methods are not (plasma diameter lower than 10 wave lengths). The feasibility of this method is tested with a plasma at atmospheric pressure and a 2 mm incident wavelength. The plasma is obtained by the laminar flow of a plasma torch, with a working gas (He or Ar) seeded by potassium (density continuously variable between 10^{11} and 10^{15} e/cm^3). Some diffraction patterns by this plasma and for various incident waves are also given and explained with theoretical calculations. Author (NSA)

N67-38937*# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
AN INVESTIGATION OF CURRENT SHEET STRUCTURE IN A CYLINDRICAL Z-PINCH

William R. Ellis, Jr. (Ph.D. Thesis) Jul. 1967 325 p refs
(Grants NsG-306-63; NSF GP-579)
(NASA-CR-89277; Rept.-805) CFSTI: HC $3.00/MF $0.65 CSCL 20I

The structure of the propagating current sheet in a large radius cylindrical pinch discharge is investigated experimentally at representative locations in the discharge chamber. Quantitative field measurements and current density distributions are obtained using conventional electric and magnetic probes. Electron number densities, temperatures, and collision frequencies are measured with a microwave reflection probe developed for this application. This probe can return quantitative information with a spatial resolution of 2 mm over the density range $10^{12} < n_3 < 10^{16}$ cm^{-3}. The experimental data are related through appropriate continuum models to provide information on the mechanisms of gas acceleration and current conduction in the sheet. The sheet is found to have four interior zones wherein scalar or Hall conduction variously dominate, and ion current is found to be significant in two of these zones. Ionization profiles are obtained and a two step mechanism is suggested wherein initial photoionization is abetted by electron collisions. The velocity increase imparted during gas acceleration is found to be comparable with the sheet velocity, and the axial flow deflection is calculated to be small. Author

N67-39000*# Purdue Univ., Lafayette, Ind.
SCHOOL OF AERONAUTICS, ASTRONAUTICS, AND ENGINEERING SCIENCES. NONEQUILIBRIUM RADIATION AND IONIZATION IN SHOCK WAVES
Clair E. Chapin Jun. 1967 134 p refs
(Contracts NAS8-11485; N00014-67-A-0226-0001)
(NASA-CR-89069; AA&ES-67-9; AD-656767) CFSTI: HC $3.00/MF $0.65 CSCL 20I

Radiation energy transfer and ionization rates in the mixture of atoms, ions and electrons produced by a normal shock wave propagating in cold argon gas are examined. It is shown the gas may be regarded as a combination of two gases, one composed only of electrons and one composed of both atoms and ions. Temperature differences between the electron gas and the atom-ion gas significantly affect radiation and ionization rates in the shock wave. The analysis uses the ionization rates due to both atom-atom collisions and electron-atom collisions. In addition, photoionization, which is responsible for precursor ionization, is included.
Author (TAB)

N67-39044 Joint Publications Research Service, Washington, D. C.
PRODUCTION OF AN INVERSE POPULATION BY MIXING OF A HOT PLASMA WITH A COLD GAS
L. V. Popov 9 Oct. 1967 12 p refs Transl. into ENGLISH from Zh. Prikl. Spectroscopy (Moscow), v. 5, no. 2, Aug. 1966 p 188–194
(JPRS-42891; TT-67-33517; UDC-535.34; UDC-553.9) CFSTI: $3.00

An analysis of a model in which the interaction of a hot plasma and a cold gas is used to create an inverse population. The impossibility of producing an inversion with high electron concentrations ($n_1 \approx 10^{16}$ cm^{-3}) is proven on the example of hydrogen, and conditions are presented under which the inversion can be realized. Author

N67-39057# Princeton Univ., N. J. Plasma Physics Lab.
LIMITATION ON ION CYCLOTRON HEATING IN THE LOCAL MIRRORS OF THE C STELLARATOR
A. Iiyoshi, H. Yamato, and S. Yoshikawa Oct. 1966 31 p refs
(Contract AT(30-1)-1238; NSF GP-579)
(MATT-411) CFSTI: HC $3.00/MF $0.65

The experimental observation of the limiting phenomena of ion cyclotron resonance heating in the shallow magnetic beach is described and its explanation by the reflection of the wave is discussed. The temperature-anisotropic plasma dispersion relation is solved with the aid of an electronic computer. The unexpected singular point which causes the reflection of waves is found in the unstable region of the ion cyclotron wave. The calculated limiting value of the ion temperature due to the wave reflection is given by $\beta_{\perp c} \approx 4(T_{\parallel}/T_{\perp})^2$, is reasonable agreement with the experiment.
Author

N67-39128 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
CHARACTERIZATION OF RE-ENTRY PLASMAS IN HYPERSONIC HOT-SHOT WIND TUNNELS [CARACTERISATION DES PLASMAS DE RENTREE DANS LES SOUFFLERIES HYPERSONIQUES A ARC]
Didier Compard and Jacques Dorey 1967 5 p refs Presented at the 8th Intern. Conf. on Phenomena of Gas Ionization, Vienna, 27 Aug.–2 Sep. 1967
(ONERA-TP-488(1967))

The hot shot wind tunnel, because of its high stagnation conditions, can give plasma characteristics comparable to some of those encountered during actual reentry. An example of the electron density calculation along a specific streamline corresponding to typical hot shot conditions and for a 5 cm nose radius hemisphere-cylinder is given. The results show the importance of nonequilibrium effects and the possibility of placing small probes in the flow field without producing an important ionization. Triple probes were used in hot shot tunnel experiments operating at the limit of free molecularity. They gave the necessary couple of data (current and potential) for determining electron density and temperature. Typical results of density measurements in the shock layer and wake of different models are presented. In addition, the results of seeding tests in which ionic density was measured by the triple probe method are discussed. R.N.A.

N67-39190 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TURBULENT FLOW OF AN ELECTROCONDUCTIVE FLUID IN A LONGITUDINAL MAGNETIC FIELD [TURBULENTNOYE TECHENIYE ELEKTROPROVODNOY ZHIDKOSTI V PRODOL'NOM MAGNITNOM POLE]
D. S. Kovner *In its* News of Inst. of Higher Learning. Astron. Eng. 27 Apr. 1967 p 235–240 refs (See N67-39169 23-32)

Applying the semi-empirical theory of turbulence, the author considers the development of turbulent flow conditions in a longitudinal magnetic field within a tube. Adopting an expression for the dissipation of the kinetic energy of the turbulent movement due to the magnetic field and on the basis of several assumptions introduced for the purpose of simplifying the problem, a formula is derived for the profile of the mean velocity and the coefficient of hydraulic resistance. Criteria are obtained which define the velocity profile configuration and the dependence of the hydraulic resistance factor on the induction of the magnetic field in the case of turbulent flow conditions. This is of great utility in the correct processing of the experimental data. Moreover, it is shown that for highly-developed turbulent motion it is sufficient to determine experimentally the value of a single factor, for which an upper estimate has been made. Author

N67-39202# Los Alamos Scientific Lab., N. Mex.
INTENSE SOURCE OF NEUTRONS FROM THE DENSE PLASMA FOCUS
J. Mather [1966] 13 p refs Presented at the 2nd Intern. Symp. on Nucleonics in Aerospace, Columbus, Ohio.
(Contract W-7405-ENG-36)
(LA-DC-8124; CONF-670714-1) CFSTI: HC $3.00/MF $0.65

The dense plasma focus (created in a coaxial accelerator) is an intense source of neutrons. The plasma focus can be described as a fast dynamic z pinch in which stored magnetic energy is rapidly converted to plasma energy and then compressed by its self magnetic field. Plasma pressures (nkT) of the order of 3×10^5

atmospheres are developed on axis in a region of ≈0.5-mm diameter and 3 to 5 mm in length. The deuterium plasma density $n \geq 2$ to 3×10^{19}/cc, electron temperature T≈5 keV and a neutron pulse duration of ≈0.15 μsec lead to a large neutron emission which is not inconsistent with the assumption of thermonuclear origin. Scaling of the dense plasma focus to larger input energies and larger physical size should permit on the basis of experimental evidence higher neutron production. The characteristics of this type of source which are relevant to its potential use as a neutron source in experiments are discussed. Author (NSA)

N67-39234# Princeton Univ., N. J. Plasma Physics Lab.
MEASUREMENT OF ION TEMPERATURES IN A BARIUM PLASMA
J. G. Hirschberg, J. E. Hesser, E. Hinnov, and N. Rynn Oct. 1966 25 p refs
(Contract AT(30-1)-1238)
(MATT-461) CFSTI: HC $3.00/MF $0.65

The Doppler profiles of the λ4934 line of the Ba^+ component of the plasma column in the Q-1 device were measured by means of a pressure swept photoelectric Fabry-Perot spectrometer under a variety of conditions. It was found that the ion kinetic energies, perpendicular to the confining field, deduced from these profiles, were generally considerably higher than the electron temperatures or the temperature of the ionizing rhenium plate, the latter being 2800°K in all the measurements. Two types of plasma were examined, pure barium and a mixture of Ba and Cs. In a pure barium plasma, the apparent ion temperature decreased from about 13,000°K at plasma density of 2×10^{10} cm^{-3} to 5600°K at 7×10^{10} cm^{-3} and, by extrapolation, would have reached the electron temperature at a density of about 2×10^{11} cm^{-3}. In a mixture of cesium and barium, the ion temperatures were still considerably higher, and approached electron temperature only at an estimated density of about 10^{12} cm^{-3}. The electron temperature also was elevated, 3700°K, in the mixture of cesium and barium. An axial current imposed on the plasma, in the case of pure Ba^+, was also observed to decrease the apparent ion temperature as well as the plasma density, although at all values of current that were used, the ion temperature exceeded the electron temperature. Author

N67-39256* California Univ., Los Angeles. Dept. of Physics.
LINEAR AND NONLINEAR THEORY OF GRID EXCITATION OF LOW FREQUENCY WAVES IN A PLASMA
George L. Johnston Apr. 1967 97 p refs
(Grant NGR-05-007-116; Contract Nonr-4756(01))
(NASA-CR-89281; R-13) CSCL 20I

The steady-state response of an infinite, uniform expanse of hot, rarefield plasma to low-frequency excitation by a pair of idealized parallel plane grids was investigated. The Vlasov equation for grid excitation of longitudinal waves was considered both in the linearized (infinitesimal amplitude) limit and in the weakly nonlinear case of small but finite amplitude disturbances. Author

N67-39285 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
QUESTIONS OF MAGNETOHYDRODYNAMICS III [VOPROSY MAGNITNOY GIDRODINAMIKI III] Selected Articles
11 May 1967 29 p refs Transl. into ENGLISH from Tr. Fiz. Inst., Akad. Nauk SSR (Moscow), 1963 p 5–8, 395–405
(FTD-MT-65-293; TT-67-62353; AD-655362)

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N67-39286 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPROXIMATE CALCULATION OF A CONDUCTIVE MHD-GENERATOR WITH USE OF THE CONCEPT OF ENTROPY [PRIBLIZHENNYY RASCHET KONDUKTSIONNOGO MGD-GENERATORA S ISPOL'ZOVANIYEM PONYATIYA ENTROPII]
D. A. Munshtukov *In its* Questions of Magnetohydrodyn. III 11 May 1967 p 1–13 refs (See N67-39285 23-25)

Proposed is an approximation method for calculating energy conversion processes in linear magnetohydrodynamic direct current generators. Included is a brief review of existing methods used in calculations of magnetohydrodynamic generators, and inherent problems associated with the use of these methods. The proposed method is valid for unidimensional stationary motion of the electrically conductive gas when the magnetic Reynolds numbers are small and when both heat flows and end effects are absent. A further assumption is that the magnetic permeability and dielectric constant of the gas under magnetic permeability, and dielectric constant of the gas under consideration, approximate the corresponding values of the vacuum and that the gas is governed by the equation of state for an ideal gas. The basic parameters considered are the full temperature and entropy. A discussion is presented on the full temperature and its variation. It is shown that full temperature variation uniquely determines the useful work performed in the generator by a unit mass of electrically conductive gas. The prescribed entropy concept was determined on the basis of fundamental considerations and it is shown that entropy permits a simultaneous quantitative estimation of the irreversibility of the energy conversion processes in the working section of the magnetohydrodynamic generator. S.C.W.

N67-39287 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CONCERNING A DIFFERENT APPROACH TO DETERMINATION OF MAGNETIC REYNOLDS NUMBER AND BOUNDEDNESS OF THE ONE-DIMENSIONAL APPROXIMATION WITH RESPECT TO Re_m DURING FLOW OF A CONDUCTING GAS [O RAZLICHNOM PODKHODE K OPREDELENIYU MAGNITNOGO CHISLA REYNOL'DSA I ORGANICHENNOSTI ODNOMERNOGO PRIBLIZHENIYA PO Re_m PRI TECHENII PROVODYASHCHEGO GASA]
G. A. Popov and V. B. Tikhonov *In its* Questions of Magnetohydrodyn. III 11 May 1967 p 15–19 refs (See N67-39285 23-25)

Several definitions of the magnetic Reynolds number (Re_m) are analyzed and it is shown that for a turbulent flow the Re_m is definable as the ratio of magnetic field carry-off by the flow to the rate of magnetic field diffusion into the flow. Critically analyzed are definitions given in the literature on laminar flows; specifically, that (1) Re_m is the ratio of induced current to current required to develop a given external magnetic field at single coil turn; (2) that it is the ratio of the plasma current induced magnetic field to an applied external magnetic field; and (3) that it characterizes the ratio of inertial forces to electromagnetic body forces. Limitations imposed by such definitions are examined, and a corrective value for eliminating inherent problems associated with the use of the prescribed definitions is proposed. S.C.W.

N67-39332# Technische Hochschule Hannover (West Germany). Institut fuer Plasmaphysik.
INVESTIGATIONS OF EXPLODING WIRE PHENOMENA, SHOCK WAVES, AND PINCH DISCHARGES [UNTERSUCHUNGEN AN DRAHTEXPLOSIONEN, STOSSWELLEN UND PINCH-ENTLADUNGEN]

D. Meiners Jun. 1967 20 p refs In GERMAN; ENGLISH summary
(BMWF-FBK-67-49)

The following different problems are treated: (1) Exploding wire phenomena at high voltage and high ambient gas pressure. (2) Investigation of electric discharges along a laminar jet of condensed gas. (3) Construction of a 200 kJ Θ-pinch experiment for measuring line broadening by linear Stark effect. (4) Enhancement of shock wave velocity by heating the gas within the driver section of a conventional shock tube by means of a discharge initiated by an exploding wire. Author (NSA)

N67-39336# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.
FINITE AMPLITUDE INSTABILITIES IN WEAKLY IONIZED GASES AND SOLIDS
Roy R. Johnson and O. Holter (Oslo Univ.) Jun. 1967 103 p refs Presented at the 2d Orsay Summer Inst. on Non-linear Effects in Plasmas, Orsay, France, Sep. 1966
(DI-82-0626)

A study of macroscopic instabilities which can have a finite amplitude is presented. Beginning with the helical instability for the positive column in a longitudinal magnetic field as derived from a perturbation analysis, the theory is generalized to include the region of magnetic fields where the amplitude of the instability can no longer be considered small relative to the time-averaged background plasma density. The theory of the finite amplitude helical instability includes calculations of the hysteresis effect, frequency and wavelength of the helix, and the internal magnetic field. The conditions whereby the finite amplitude helical instability can cause the excitation of higher modes are considered. Experimental evidence of the behavior of the helical instability is presented. The theory for the helical instability in solid state plasmas is developed which includes the behavior of plasmas caused by injection and impact ionization in addition to the thermal carriers. Author

26 PHYSICS, SOLID-STATE

Includes semiconductor theory; and superconductivity. For applications see: 16 Masers. For related information see also: 10 Electronics.

N67-38093# Sperry Rand Research Center, Sudbury, Mass.
FLUORESCENT ION INTERACTION IN LASER CRYSTALS Semiannual Technical Summary Report, Period Ending 31 May 1967
William W. Holloway and Michael Kestigian 31 May 1967 37 p refs
(Contract N00014-67-C-0266; ARPA Order 306; Proj. Defender)
(SRRC-CR-67-35; AD-657250)

Factors influencing the fluorescence of the neodymium ion in garnet crystals (especially Y3Al5O12) were investigated in order to improve the laser characteristics of these materials. In order to increase the doping levels of the active ions, the effect of compensating ions on the concentration of neodymium ions for given growth conditions was investigated. Possible deleterious effects in the optical properties of the active ion in the presence of these compensating ions were also studied. The use of energy transfer to enhance the fluorescence of the neodymium ion was considered. Energy transfer from the cerium ion to the neodymium ion was observed. In a collateral study, the optical properties of the cerium ion in garnet crystals were extensively investigated. Methods of improving the efficiency of the energy transfer in these materials were considered. TAB

N67-38096# Navy Underwater Sound Lab., New London, Conn.
MEASUREMENT OF THE DISSIPATION ASSOCIATED WITH THE ELECTROMECHANICAL COUPLING IN PIEZOELECTRIC CERAMICS
Ralph S. Woollett (Ph.D. Thesis) 12 Jul. 1967 143 p refs
(USL-834; AD-657169)

An investigation was made to develop methods for precise measurements of velocity or displacement (including their phase angles as well as their magnitudes) and to apply these methods to extend the knowledge of the dissipative parameters of piezoelectric ceramics. Laser interferometry is a very promising new method for measuring small vibrations. In this method the motion of a small mirror attached to the vibrating body phase-modulates the light beam, and the light beam is subsequently demodulated by a photomultiplier tube. An electronic control system was developed to stabilize the interferometer against low-frequency building vibrations. In this system the mirror of the interferometer that is normally fixed is mounted on a small piezoelectric transducer. This transducer is driven by a servo amplifier in such a manner that it keeps the path length of the interfering beams constant at low frequencies. Building vibrations thus are canceled out, but the control system becomes inoperative above 1 kHz and, hence, does not interfere with the measurement of the desired vibration signals, which are in this upper frequency range. Another feedback control system was developed to stabilize the amplitude of the laser output, which was found to fluctuate as much as 10 percent. These fluctuations were reduced to about 1 percent. After suitable measurement methods had been developed, measurements were made of the electromechanical transfer ratios of a number of ceramic samples. Author (TAB)

N67-38104# Lincoln Lab., Mass. Inst. of Tech., Lexington.
SUPERCONDUCTING TRANSITION TEMPERATURE AND ELECTRONIC STRUCTURE IN THE PSEUDOBINARIES Nb_3Al–Nb_3S AND Nb_3Sn–Nb_3Sb
Frank J. Bachner, John B. Goodenough, and Harry C. Gatos 10 Aug. 1967 26 p refs
(Contract AF 19(628)-5167)
(ESD-TR-67-299; TR-1967-37; AD-657020)

The system Nb3AlySn1-y exhibits complete solid solubility, a positive Seebeck voltage that increases monatomically from 1.8 to over 12 microvolts/deg. K, and a superconducting transition temperature Tc that has a broad minimum of Tc approx. = 15.3K at about y = 0.5. The pseudobinary Nb3Sn1-xSbx, on the other hand, contains two phases, each with the A15 structure, in the interval $0.3 < x < 0.8$. Whereas the Seebeck voltage of the low-Sb phase is positive and has a Tc > 14K, the high Sb phase has a negative Seebeck voltage and is not superconducting above 4.2K. These properties were interpreted with the aid of a qualitative band-structure scheme. Thus, the rapid drop in Tc to below 4.2K in the system Nb3Sn1-xSbx is believed to be associated with the filling of the bonding, interchain d sub pi bands of the Nb subarray. Author (TAB)

N67-38109# Chicago Univ., Ill.
THE COVALENT BOND IN CRYSTALS. II: PARTIALLY IONIC BINDING
J. C. Phillips 1967 38 p refs
(Contract Nonr-2121(22))
(AD-657433)

The general theory of covalent bonding developed in AD-657 432 is extended to heteropolar crystals. In diatomic crystals the theory depends on two parameters, an energy gap for each atom, or an energy gap for the medium and a polarizability parameter eta. The latter can be determined by comparison with empirical pseudopotential form factors; the value obtained for GaAs and ZnSe which brings the form factors of the latter into agreement with the ion core form factors of Animalu and Heine, is eta = -0.05 + 0.05 or - 0.05. This polarizability parameter can be used

to estimate the effective charge ec^* defined by Callen, which describes the splitting of longitudinal and transverse optic modes of vibration at q = 0. The result in GaAs is $ec^*/e = 0.14 + 0.04$ or - 0.04, in rough agreement with the experimental value of 0.20 + 0.03 or - 0.03. The experimental values for ec^* may be used to estimate the gap parameters for each atom when complete data are available. Author (TAB)

N67-38111# Boeing Scientific Research Labs., Seattle, Wash. Plasma Physics Lab.

RECOMBINATION AND DIFFUSION IN INJECTED ELECTRON-HOLE PLASMAS

Betsy Ancker-Johnson and William P. Robbins Aug. 1967 23 p refs

(D1-82-0630; AD-657401)

The decay of injected plasmas, produced in p-InSb at 77 K, between 20 nsec and 5 microsec after the driving voltage is cut off is being studied in the absence and presence of magnetic fields. The purpose of the present investigation is to try to determine the loss mechanisms and then influence the plasma decay by various magnetic field configurations. What is presently known about the steady-state distribution before decay is allowed to begin is described first. Then it is shown that the properties of the early decay depend on initial density, but all decay becomes exponential in time after approximately 700 nsec. The fundamental mode of decay in which carriers everywhere in the sample are lost at the same rate is not established by 5 microsec. The preliminary results on decay of a plasma placed in an axial magnetic field show that the number of particles remaining after a given time, e.g., 50 nsec, is reduced as the field is raised from 0 to approximately 150 G and then, with a further slight increase in field strength, markedly enhanced. This enhancement extends over only a narrow interval of magnetic field. Sometimes oscillations in the number of surviving particles are observed as a function of magnetic field. TAB

N67-38121# Paris Univ. (France).

RADIATION DAMAGE IN SEMICONDUCTORS Final Report, 1 Jul. 1965–30 Jun. 1966

Pierre Baruch, Alain Brelot, Keiji Matsui, Jean Zizine, and Jacques Bourgoin Dec. 1966 41 p refs

(Contract AF 61(052)-543)

(AD-657365)

Work is reported in the following areas: (1) Photon irradiation enhanced diffusion in germanium at temperatures above 600 degrees C; (2) Photoconductivity of electron-irradiated silicon at 20 degrees K; (3) Low temperature annealing of N-type germanium; (4) Fast annealing of pulse-irradiated germanium (preliminary work in progress). TAB

N67-38125*# Scientific Translation Service, La Canada, Calif.

THE MECHANISM OF CONDUCTIVITY IN DEFECTIVE NIOBIUM MONOCARBIDE [O MEKHANIZME PROVODIMOSTI V DEFEKTNOM MONOKARBIDE NIOBIYA]

A. I. Avgustnik, O. A. Golikova, V. S. Neshpor, and S. S. Ordan'yan Washington, NASA, Oct. 1967 7 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Neorgan. Materialy (Moscow), v. 3, no. 2, 1967 p 286–291

(Contract NASw-1496)

(NASA-TT-F-11304) CSCL 20L

The dependence of Hall's coefficient on the composition of astoichiometric monocarbides of niobium in the homogeneity region is studied. Author

N67-38140# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

INTERACTION BETWEEN FREE ELECTRONS AND INTENSIVE LIGHT BEAM—MULTIPHOTON PROCESSES OF THE CARRIERS IN SEMICONDUCTORS

Yu-ping Ho 25 Jan. 1967 29 p refs Transl. into ENGLISH from Wu Li Hsueh Pao (Peking), v. 21, no. 1, 1965 p 37–50

(FTD-TT-65-1053; TT-67-62631; AD-657017)

The paper discusses the interaction between carriers in semiconductors and a laser beam. The influence of intensive light on the intraband motion of electrons is treated. The conclusion is that the states of the electrons within one band can still be characterized by a set of quantum numbers -- the quasi-momentum p and that the wave function contains a factor describing the forced motion in the extremely strong electromagnetic field. The interband transition and other intraband scattering are then treated as perturbations. During the transition process, the forced motion changed with the absorption or emission of a number of photons. The absorption constants for multi-photon processes of free carriers absorption and the direct transition from valence band to conduction band are calculated. It was estimated that in some materials the two-photon process of the type discussed can be easily observed-especially the direct absorption of two photons in Ge. It was pointed out that using the laser light the absorption lines of the exciton may be shifted to the infrared region, so that the resolving power may be improved. The case of CdSe was discussed as an example. TAB

N67-38171# Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy.

ON THE SOLID SOLUTIONS OF TIN TELLURIDE AND LEAD TELLURIDE

A. M. Reti, A. K. Jena, and M. B. Bever 14 Aug. 1967 12 p refs Presented at the Tech. Conf. on Prepn. and Properties of Elec. Mater., New York, 28–30 Aug. 1967

(Contract Nonr-3963(19))

(TR-4; AD-656912)

Work is described which shows that in the system SnTe-PbTe (1) the solid solutions have small exothermic heats of formation based on the binary compounds, (2) solid solution hardening is almost absent, (3) the Sn and Pb atoms are randomly distributed on the sublattice occupied by them and do not undergo an ordering transition during a thermal treatment designed to promote such a transition and (4) the lattice parameter changes linearly with composition. These findings suggest that the solid solutions of tin telluride and lead telluride approach ideal behavior. Author (TAB)

N67-38270# Illinois Univ., Urbana. Dept. of Physics.

APPARATUS FOR MEASUREMENT OF TRANSPORT PROPERTIES OF PHOTOCARRIERS IN INSULATING CRYSTALS

J. A. Borders (Ph.D. Thesis) and J. W. Hodby [1966] 27 p refs

(Contract DA-31-124-ARO(D)-217)

(AROD-4928-6-P; AD-657357)

In this paper the authors discuss apparatus suitable for detailed study of photoconductivity in wide band gap insulating crystals such as the alkali and silver halides. The sensitivity and accuracy of measurement possible with this apparatus exceeds that of previous designs by two orders of magnitude. The apparatus has been used for several months in a study of the transport properties of alkali, silver and thallium halides. New results have been obtained such as the observation of cyclotron resonance and of spin-polarized scattering. Author (TAB)

N67-38271# Chicago Univ., Ill. Dept. of Physics.

THE COVALENT BOND IN CRYSTALS: I: ELEMENTS OF A STRUCTURAL THEORY

J. C. Phillips [1966] 34 p refs

(Contract Nonr-2121(22))

(AD-657432)

An a posteriori theory is developed for the structural energy of covalent crystals. The microscopic theory is based on ionic

pseudopotentials and valence dielectric screening. The theory explains the difference between empirical pseudopotential form factors derived from the optical spectra of semiconductors and the metallic form factors calculated from free ion term values by Animalu and Heine. A by-product of the theory, which utilizes Penns model isotropic semiconductor dielectric function, is a relation between the covalent bonding charge and the macroscopic dielectric constant. The extension of the theory to III-V and II-VI semiconductors is described briefly. The theory may be used to calculate elastic and macroscopic dielectric properties of covalent crystals starting only from ionic pseudopotential form factors. Author (TAB)

N67-38299# Los Alamos Scientific Lab., N. Mex.
JOSEPHSON TUNNELING IN SUPERCONDUCTORS
Leonard W. Gruenberg Jun. 1965 20 p refs
(Contract W-7405-ENG-36)
(LA-3414-MS) CFSTI: HC$3.00/MF$0.65

The pseudospin model of supersonductivity is discussed and applied to a discussion of Josephson tunneling between superconductors. Author (NSA)

N67-38321# Massachusetts Inst. of Tech., Cambridge.
SOLID-STATE AND MOLECULAR THEORY GROUP
John C. Slater et al 15 Jul. 1967 114 p refs
(Contracts Nonr-1841(34); AF 19(628)-356; Grants NSF G-24908; NSF GP-3241; NSF G-10821)
(QPR-65; AD-655966)

Contents: Lectures on the energy band theory of magnetism; Exchange in magnetic atoms; A note on the l-convergence of the APW method; Some primitive thoughts on localized moment structure in metals; Impurity screening in an inhomogeneous electron gas II. mass operator formalism: point impurity in the surface region; Field theory of an interacting electron gas in a periodic potential; The quantum origin and significance of Maxwells equations. TAB

N67-38363# Pennsylvania State Univ., University Park. Materials Research Lab.
MATERIALS PREPARATION AND CHARACTERIZATION RESEARCH Technical Summary Report, 1 Jul. 1966–30 Jun. 1967
Rustum Roy 30 Jun. 1967 69 p refs
(Contract DA-49-083-OSA-3140; ARPA Order 338)
(AD-657237)

Research progress and results in the following areas are reported: Growth of large crystals (flux method, hydrothermal growth, growth from melt, traveling solvent method, vapor growth, nucleation studies); new growth techniques (growth of concentrated crystalline solutions, crystal growth in gels, plasma synthesis); application of the electron microprobe to the characterization of solids; new technique for the study of extended x-ray absorption fine structures; instrumentation for vacuum path recording of x-ray absorption structure; instrumentation for studies of x-ray-excited luminescence; scanning electron microscope; polytypism in PbI2; dislocation probe technique for characterization of defects induced by surface contamination and gamma-irradiation; characterization by x-ray methods; structure analysis and crystal physics; the system, Zn-Fe-S as a geothermomter. TAB

N67-38380 Kyoto Univ. (Japan). Research Inst. for Fundamental Physics.
THEORY OF IMPURITY-INDUCED INFRARED LATTICE ABSORPTION IN ALKALI HALIDE CRYSTALS
Shozo Takeno Jul. 1967 61 p refs
(RIFP-61)

A study is made of the impurity-induced infrared lattice absorption of alkali halide crystals containing substitutional alkali or halide ion impurities using specific but exactly soluble crystal (Rosenstock-Newell model) and impurity models and taking into account the change in force constants as well as the change in mass accompanying the introduction of the impurities. The absorption coefficient of the crystal is calculated within the framework of harmonic approximations using the method of double-time Green's functions. An expression for the total dipole moment of the crystal is reduced to a form which can be expressed entirely in terms of the displacements of the impurities. Particular attention is paid to the one-impurity problem assuming the concentration of the impurities is small. It is shown that all the quantities entering into the one-impurity problem can be expressed entirely in terms of the diagonal part of phonon Green's functions for the pure crystal. A detailed discussion is given of the properties of infrared-active phonon impurity modes, which are localized modes or localized gap modes (modes appearing in the gap between optical and acoustical branches of phonons) or resonant modes. Author

N67-38384# Duke Univ., Durham, N. C. Dept. of Electrical Engineering.
A STUDY OF SPIN-WAVE SPECTRA AND SURFACE EFFECTS IN THIN NICKEL FILMS DEPOSITED IN ULTRA-HIGH VACUUM
William Forrest Chambers May 1967 141 p refs
(Contract AT(40-1)-2430)
(ORO-2430-39) CFSTI: HC$3.00/MF$0.65

Multiple spin-wave resonances have been observed in thin nickel films deposited on glass substrates held at elevated temperatures. Shadowed-surface-replica and direct-transmission-electron micrographs of these films show that they have very rough surfaces; many surface bumps are nearly as high as the films are thick. It has been deduced from the surface measurements that the stress patterns in such films are very complex and that a dynamic pinning model yielding weak pinning through an internal stress field variation or through a surface-bump-caused variation in the internal-magnetic-field intensity will provide the most appropriate model for a theoretical analysis of spin-wave resonance in such films. Measurements of average grain size and surface–bump heights in the films indicate that the film formation mechanism proposed by Wilman is applicable to films deposited in ultrahigh vacuum. Hysteretic resonances that occur at applied magnetic field intensities of less than $4\pi M$ and an anomalous low power absorption by the first resonance mode are reported. The nickel films used varied in thickness from 50 to 5000 Å and were deposited by electron bombardment. The background pressures during deposition were varied from 1×10^{-7} to 4×10^{-10} torr while the substrate temperatures were varied from room temperature to 350°C. Author (NSA)

N67-38406# Duke Univ., Durham, N. C. Dept. of Electrical Engineering.
X-RAY ANALYSIS OF STRESS IN THIN GOLD FILMS
Blake McDowell Apr. 1967 100 p refs
(Contract AT(40-1)-2430)
(ORO-2430-38) CFSTI: HC$3.00/MF$0.65

A general X-ray diffraction analysis was formulated to study strain in thin films. This formulation makes three basic assumptions: the existence of a relatively unstrained reference; a large number of crystallites within the incident X-ray beam; and the strain varies only in a direction normal to the surface. Bulk gold was used as the reference because of the accurate correspondence of the off-annealed films' peak shapes to those of bulk. The second assumption was confirmed by an electron microscope examination which showed that at least 2.5×10^{8} crystallites were within the diffracted beam. The justification of the thrid assumption was the accuracy with which the data corresponded to the formulation. The results of linear and nonlinear analyses are discussed. Author (NSA)

N67-38410# Martin Co., Baltimore, Md. Research Inst. for Advanced Studies.

SURFACES AND INTERFACES IN MATERIALS TECHNOLOGY

Albert R. C. Westwood and R. G. Lye Aug. 1967 92 p refs (Contract Nonr-4162(00))

(RIAS-TR-67-12-C; TR-10; AD-657380)

Surfaces and interfaces are involved in many aspects of engineering technology. Of particular interest to materials scientists are those aspects in which phenomena occurring at external or internal surfaces determine mechanical behavior, or electronic properties. Factors involved in some of these effects, and in such important surface phenomena as friction, lubrication and wear, sintering, welding and adhesion, are reviewed and briefly discussed. Author (TAB)

N67-38466# International Business Machines Corp., Hopewell Junction, N. Y. East Fishkill Facility.

INFRARED ANALYSIS TECHNIQUE FOR DETERMINING ALUMINUM-PHOSPHOSILICATE REACTION

M. M. Nanda, E. A. Corl, and S. L. Silverman *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 83–100 refs (See N67-38461 23-09)

Inversion, a major cause of semiconductor failure, is frequently caused by the build-up of trapped charges in the vicinity of the silicon/silicon dioxide interface. A phosphosilicate layer introduced into the silicon dioxide structure reduces the failure incidence due to inversion, but aluminum interconnections react chemically with the oxide, reducing the phosphosilicate layer. Reflection infrared spectroscopy is a practical non-destructive technique in determining phosphosilicate layer thickness on oxidized silicon wafers. It was shown that depletion of the phosphosilicate layer occurs because of interaction with aluminum under various times and temperatures. The practical applicability of this infrared method in the quantitative determination of the depletion of the phosphosilicate layer is proven. Experimental findings show that the reflection technique can be used in process development and in production control of transistors and diodes using aluminum as interconnection. Author

N67-38469# Standard Telecommunication Labs., Ltd., Harlow (England).

THE INTERACTION OF OXYGEN WITH CLEAN CHROMIUM FILMS AND ITS INFLUENCE ON THE ELECTRICAL FILM PROPERTIES

W. A. Crossland and H. T. Roettigers *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 158–182 refs (See N67-38461 23-09)

(Contract AF 61(052)-923)

An approach to the investigation of ageing mechanisms in thin film resistors is presented. The program includes the separation of most of the deterioration processes by using single crystal and polycrystalline chromium films deposited at ultra-high vacuum and the detailed study of the various gas–metal interaction stages during oxidation, which is considered to be one of the most important ageing mechanisms. The experimental procedures are described and results presented from the first stage of the investigations giving the process kinetics and their impact on the electrical properties of chromium films. The results are consistent with Mott and Cabrera's theory for thin oxide films, where the growth is determined by a field dependent cation diffusion through the oxide. Author

N67-38471# Research Triangle Inst., Durham, N. C.

THE OXIDE–SILICON INTERFACE

R. P. Donovan *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 199–231 refs (See N67-38461 23-09)

Oxidized silicon surfaces, used on virtually all integrated circuits and silicon devices, and surface related failures are discussed. Device surface operation, whether it be any of the MOS family or simply a planar p–n junction, is predicated upon the action of the space charge region in the silicon that is adjacent to the oxide–silicon interface. The observed device properties are well described by simple models in which the surface conductance, capacitance, recombination velocity and other electrical properties are uniquely related to the surface potential. Extraneous charges in the oxide–silicon system that are not part of the silicon space charge region do exist, however, and constitute a source of degraded device performance, instability, and failure. Author

N67-38474# Texas Instruments, Inc., Dallas. Semiconductor-Components Div.

CLEAN METAL OXIDE SEMICONDUCTOR SYSTEMS

H. G. Carlson, C. R. Fuller, D. E. Meyer, J. R. Osborne, V. Harrap et al *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 285–291 refs (See N67-38461 23-09)

(Contracts AF 30(602)-3723; AF 30(602)-3727)

Aspects of sodium contamination of metal–oxide–silicon (MOS) systems associated with silicon surface preparation, the oxidation planum, and post-oxidation procedures, including contact application, are discussed. The validity of neutron activation analysis to determine sodium distributions in MOS samples is established. Refractory materials for furnace construction are examined and shown to contain as much as 1–5 percent sodium or potassium. Use of multiwall quartz furnace tubes as well as cold wall *r-f* heated systems is shown to give low sodium content oxides. Sodium levels as low as 4×10^{15} atoms/cc in the oxide, with no detectable increases at either interface of the oxide, have been attained. Author

N67-38475# Westinghouse Electric Corp., Pittsburgh, Pa. Research Labs.

MIGRATION OF GOLD AND NICKEL IONS IN THIN FILMS OF SILICON DIOXIDE

J. R. Szdeon and R. M. Handy *In* RADC Phys. of Failure of Electron., Vol. 5 Jun. 1967 p 292–309 refs (See N67-38461 23-09)

(Contract AF 33(615)-3390)

Reversible migration of contaminant or electrode metal ions in insulating films has been blamed for short to medium term instability in the electrical behavior of tunneling, surface-controlled, and planar devices. Ultimate failure of devices in many cases is attributed to the irreversible migration of ions. The irreversible migration of electrode metal ions in silicon dioxide films is discussed here. Primary emphasis has been on the development of techniques for obtaining concentration profiles of Ni and Au in thermally grown films of SiO_2 before and after the induction of ion migration. Mass spectroscopy, employing a variant of the spinning electrode spark source, has been used to detect nickel migration. Radio-tracer counting, combined with oxide etch-back, has given specific, sensitive and quantitative results in the case of gold migration. Author

N67-38482# TRW Semiconductors, Inc., Lawndale, Calif.

EFFECT OF THERMAL OXIDE DISLOCATION ENHANCEMENT ON SILICON AND A PROPOSED MODE OF PROPAGATION

G. Onodera and P. Walker *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 444–446 (See N67-38461 23-09)

The probability that active dislocation centers are involved in the $Si–SiO_2$ interface and that such dislocations have a deleterious effect of voltage breakdown and leakage is acknowledged. Studies of the effect of thermal oxidation and its role in propagation of dislocations show that the type of dislocation and propagated depth can be correlated with the oxide thickness. A series of oxide experiments were run with Czochralski (100) oriented n-type

Si of 5 to 6 ohm-cm resistivity using 85 C O_2 at 1120 C. All wafers were polished etched and, immediately prior to oxidation, were boiled in hot HNO_3, rinsed in dionized water, and held under water until introduced into the oxidation furnace. Silicon dioxide was thermally grown between 100 A and 5200 A. After oxidation, the oxides were removed with HF and the wafers etched to observe dislocation enhancement due to oxide growth. Author

N67-38486# Fairchild Semiconductor Corp., Palo Alto, Calif. Research and Development Labs.
THE FAILURE OF THIN ALUMINUM CURRENT-CARRYING STRIPS OF OXIDIZED SILICON
Ilan A. Blech and Harry Sello *In* RADC Phys. of Failure in Electron., Vol. 5 Jun. 1967 p 496-505 refs (See N67-38461 23-09)
(Contract AF 30(602)-3776)

A new mode of metal failures is described—electrical opens in Al strips on SiO_2—resulting from the passage of direct current at high current density. The lifetime of aluminum strips was found to depend not only on the magnitude of the applied current, but also on its direction. At lower current levels (longer lifetimes), a much longer lifetime was seen when alternating current was employed than for direct current. This effect, together with the fact that aluminum films carrying direct currents have a blistered appearance, suggests that an electrochemical or electromigration mechanism is involved in the disruption of the aluminum strips. While opens are very rarely seen at "normal" current densities, the failure mode is accelerated at high current densities and elevated temperatures. Author

N67-38499# Brown Univ., Providence, R. I. Dept. of Physics.
INTERBAND DIELECTRIC PROPERTIES OF SOLIDS IN AN ELECTRIC FIELD
D. E. Aspnes, Paul Handler (Ill. Univ., Urbana), and D. F. Blossey (Ill. Univ., Urbana) [1967] 47 p refs Prepared in cooperation with Ill. Univ.
(Contract DA-31-124-ARO(D)-454)
(AROD-8412-5-P; AD-656469)

A general expression for the imaginary part of the one-electron interband dielectric function of a solid in the presence of an electric field is derived. The result is valid for all regions of k-space and explicitly takes into account the variation of the dipole matrix element and effective mass throughout the Brillouin zone. Under certain approximations the finite electric field dielectric function reduces to the convolution of the zero field dielectric function with an Airy function. This result can be used in conjunction with band structure calculations which have already been done in order to predict the line shape of the electroreflectance spectra as a function of electric field. The convolution expression reduces further at non-degenerate critical points, and the forms for the four types of critical points are presented. In certain instances it is possible to unfold the convolution integral and obtain the zero field dielectric function from either the finite field dielectric constant or the electroreflectance data at isolated critical points. Author (TAB)

N67-38530# Illinois Univ., Urbana. Material Research Lab.
THE SCIENCE OF MATERIALS Annual Progress Report
15 Apr. 1967 76 p refs
(Contract AT(11-1)-1198)
(COO-1198-443) CFSTI: HC $3.00/MF $0.65

The object of the work, results obtained during fiscal year 1967, and the results expected in 1968 and 1969 are summarized for the following projects: solid state transformations, electronic band structure of alloys of transition metals, point defect-dislocation interactions, conduction mechanisms in semiconducting glasses, mechanical and surface behavior of crystals, first-order phase transformations in crystalline solids, annealing of cold-worked metals, nuclear magnetic resonance studies, electronic structure of alloys, magneto-optic absorption by R centers in the alkali halides, use of very high pressure to study the structure of matter, anharmonic effects in solids, defect and electronic properties of solids, properties of noble gas crystals, magnetic resonance in solids, properties of materials at very low temperatures, mechanical behavior and corrosion of coated and composite materials, and effects of high-energy-particle irradiation on properties of solids. No detailed data are included; publications are listed. NSA

N67-38531# Illinois Univ., Urbana. Dept. of Physics.
MAGNETIC SUSCEPTIBILITY AND KNIGHT SHIFT MEASUREMENTS IN ALUMINUM-RARE EARTH ALLOYS
Gary Wendell Stupian Jun. 1967 125 p refs
(Contract AT(11-1)-1198)
(COO-1198-453) CFSTI: HC $3.00/MF $0.65

Measurements of magnetic susceptibility and solvent Knight shift in dilute alloys of rare earth metals in aluminum were carried out. The susceptibility results give a clear indication that localized moments exist on each impurity except La, Yb, and Lu, and that the coupling between the total spin and the total orbital angular momentum of f electrons is dominant in determining the size of localized moments on solutes. The maximum magnitude of localized moments observed was over 10 μ_B which is impossible without a contribution to the magnetic moment from orbital angular momentum. The susceptibility also shows the deviation from Curie law behavior resulting from the population of excited states. The solvent Knight shift permitted a particularly penetrating investigation of solute structure because it is influenced only by the polarization of electron spins. The observations show conclusively that the spin magnetization opposes the total impurity magnetization in lighter rare earths while aiding it in heavier rare earths. A quantitative discussion, using scattering theory, of the electron polarization caused by magnetic impurities was found to give a satisfactory account of observed Knight shift changes. The magnitude and sense of the shifts are reproduced satisfactorily by the assumptions that the localized states are about 0.6 eV wide and that, for heavier elements containing electrons in both spinup and spindown subbands are separated by about 1 eV. A qualitative explanation of the observed NMR solvent line width for the various solutes is given. Author (NSA)

N67-38560# Naval Ordnance Lab., Corona, Calif.
FOUNDATIONAL RESEARCH PROJECTS Quarterly Report, Jan.-Mar. 1967
H. H. Caspers et al 15 Jun. 1967 88 p refs
(NOLC-715; AD-655889)

Contents: Microwave Photon Interaction with Superconducting Tunneling Currents; Phenomenon of Spin Exchange Collisions between Ions and Neutral Atoms in a Plasma; Two-Phonon Matrix Elements and Absorption for Crystal Models with Zinc Blende Structure, Part III; Energy Transfer between ND(3+) and YB(3+) in LAF3. TAB

N67-38581# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
MEASUREMENTS OF POLARIZED NEUTRON TRANSMISSION THROUGH MAGNETIZED FERROMAGNETIC MATERIALS BY A STERN-GERLACH EXPERIMENT [UNTERSUCHGEN ZUM DURCHGANG POLARISIERTER NEUTRONEN DURCH AUFMAGNETISIERTE FERROMAGNETICA MIT EINER STERM-GERLACH ANORDNUNG]
K. Brand and M. Nagib Jun. 1967 9 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-50)

A Stern-Gerlach experiment with slow monochromatic neutrons is described. A mechanical velocity selector served as monochromator. The inhomogeneous field of a Stern-Gerlach-type

magnet was used to produce two neutron beams polarized in opposite directions. With these polarized neutrons transmission measurements were made with magnetized nickel and ferrite alloy. These measurements at different magnetization of the samples give the law of the approach to magnetic saturation at high fields in form of a 1/H dependence. Author (NSA)

N67-38589*# Rice Univ., Houston, Tex. Dept. of Electrical Engineering.

EDDY-CURRENT-FREE SWITCHING OF PERMALLOY THIN FILMS

J. K. Watson and H. C. Bourne Mar. 1967 20 p refs Presented at the 5th Intern. Magnetics Conf. and Exhibits, Washington, D. C.

(Grant NsG-6-59; Contract AT(40-1)-2572)

(NASA-CR-89204; ORO-2572-11; CONF-670425-1) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Results are presented from an experimental investigation of large-angle flux reversal of magnetic films. The reported measurements were made with an unconventional instrument with design features which are briefly outlined. Switching characteristics for a selected film are shown, and are compared with results of others in region II at 2° transverse bias. Our 6 oersteds-nanoseconds is an order of magnitude faster than others although the switching field rise time is an order of magnitude slower. Conventional switching characteristics are shown to be made by transversals of measurements across a two-dimensional field plot of the film characteristics. The width of region II, the lower threshold for region II, and the independently measured dispersion field are all approximately 0.1 oersted for the subject film. Author (NSA)

N67-38591# Sandia Corp., Albuquerque, N. Mex.

HALL EFFECT MEASUREMENTS IN SHOCK-LOADED SEMICONDUCTORS

J. D. Kennedy [1967] 18 p refs Presented at the Intern. Symp. on the Behavior of Dense Media Under High Impulsive Pressures, Paris

(Contract AT(29-1)-789)

(SC-DC-66-2449; CONF-670914-7) CFSTI: HC $3.00/MF $0.65

Successful Hall effect measurements were performed before, during, and immediately after the passage of a plane shock wave through doped single crystal semiconductor specimens. A stress pulse having an amplitude slightly less than the Hugoniot elastic limit of the sample was produced by a low pressure explosive plane wave lens. Hall voltage measurements were made during the 5 μsec prior to shock wave entry and the 3 or 4 μsec during and immediately following shock propagation through the specimen. The sample was surrounded by carefully mated identical material which, for the duration of the experiment, ensured that the specimen was in a state of one-dimensional strain. A uniform magnetic field of up to 30 kG was produced in the sample by means of an expendable solenoid, and the Hall current was switched on just prior to shock wave entry into the semiconductor. Author (NSA)

N67-38853# Michigan Univ., Ann Arbor.

HYDROSTATIC PRESSURE EFFECTS ON THE EPR SPECTRA OF DOPED SAPPHIRES

John Edward Harman (Ph.D. Thesis) 1966 172 p refs

(Contract AT(11-1)-1112)

(COO-1112-115) CFSTI: HC $3.00/MF $0.65

The interaction of the isoelectronic impurity ions V^{2+}, Cr^{3+}, and Mn^{4+} with the α-Al_2O_3 crystal lattice was studied by observing the hydrostatic pressure dependence of their electron paramagnetic resonance (EPR) spectra to 6000 atmospheres. A two-sample comparison method was used in which two identical samples were placed in the X-band microwave resonant cavity. One end of the cavity and one sample were subject to hydrostatic pressure. The changes in the spin Hamiltonian parameters were obtained by measuring the difference in the magnetic field required for the same resonance condition in each sample as a function of pressure. It is concluded that the ions occupy similar lattice sites and are subject to nearly the same compressibility. Comparison with both the crystal field model and the molecular orbital model revealed that the predictions of both models for the pressure dependence were consistent and yielded a pressure dependence of the spin-orbit coupling constant λ of $\Delta\lambda/\lambda = (1.7 \pm 0.2) \times 10^{-3}$/katm. This change in λ as a function of pressure may be explained within the framework of the crystalline field theory by a contraction of the 3d wave functions, and within the framework of the molecular orbital theory by an increase in covalency. Overall consistency was maintained only by assuming the compression is approximately conformal and that the compressibility is about four times the bulk compressibility. Author (NSA)

N67-38863# Chicago Univ., Ill.

THE COVALENT BOND IN CRYSTALS. IV: LATTICE DEFORMATION ENERGIES

J. C. Phillips [1967] 21 p refs

(Contract Nonr-2121(22))

(AD-657435)

A general method is described for calculating lattice deformation energies in covalent structures. The formulae are presented explicitly for harmonic energies in diamond-type crystals. The theory differs intrinsically from linear screening theories because of the inclusion of bond stretching terms. These are calculated using a dynamical covalent sum rule. The results show that bond stretching leads to large bond-bond interaction energies that are similar to those in a nearest neighbor classical shell model. The theory can be used to infer the covalent screening function from lattice vibration spectra measured by inelastic neutron scattering. Author (TAB)

N67-38867# Lincoln Lab., Mass. Inst. of Tech., Lexington.

MAGNETIC AND STRUCTURAL STUDY OF THE SPINEL $MnYb_2S_4$

John N. Longo and Paul M. Raccah 9 Aug. 1967 11 p refs

(Contract AF 19(628)-5167)

(ESD-TR-67-340; TN-1967-36; AD-657032)

The compound MnYb2S4 has the normal spinel structure with no measurable mixing of atoms in octahedral and tetrahedral sites. The sulfur parameter is 0.380 plus or minus 0.002, which is lower than usually found in spinels. Magnetic susceptibility shows no magnetic order to liquid He temperature and a temperature dependence that is the simple sum of the theoretical contributions for Yb(3+) and Mn(2+) ions. Author (TAB)

N67-38877# Chicago Univ., Ill.

THE COVALENT BOND IN CRYSTALS. III: ANISOTROPY AND QUADRUPOLE MOMENTS

J. C. Phillips [1967] 17 p refs

(Contract Nonr-2121(22))

(AD-657434)

The form factors of covalent atoms in anisotropic environments are discussed. As an example of the general theory the bonding charge in graphite is calculated. Comparison of the planar bonding charge with the tetrahedral one leads to evaluation of the bonding charge in double and triple carbon-carbon molecular bonds. Author (TAB)

N67-38786# Princeton Univ., N. J. Plasma Physics Lab.

THE ROLE OF FERROMAGNETIC MATERIALS IN THE DESIGN OF MAGNETIC FIELDS USED IN PLASMA RESEARCH

K. E. Wakefield *In its* Plasma Phys. Lab. May 1967 p 349-353 (See N67-38725 23-25)

Reported are techniques for eliminating or reducing nonlinear perturbations in plasma fields that are caused by ferromagnetic

materials in their vicinity. A dipole formula is used to compute nonlinear and general three-dimensional magnetic effects on the field of a research device placed in the vicinity of a ferromagnetic apparatus. The ferromagnetic material is divided into a convenient number of elements of blocks where the field is expressed in terms of the energizing coil system. Computing time can be reduced by considering only the surface of the magnetic material and using a surface pole distribution to reduce the field in the interior to zero. Model calculations on a large iron yoke for a C stellarator coil determine the anticipated force by representing the surface of 234 area elements; results are within a few percent of the measured values after the device had been built. G.G.

N67-38786# Princeton, Univ., N. J. Plasma Physics Lab.
FIELD DEPENDENCE OF THE RATE OF DECAY OF PERSISTENT CURRENTS IN A NIOBIUM–ZIRCONIUM SUPERCONDUCTING SOLENOID
J. File *In its* Plasma Phys. Lab. May 1967 p 354–361 refs
(See N67-38725 23-25)
(Grant NSF GP-579)

Current decay was observed in the trapped magnetic field of a double layered niobium–zirconium wire solenoid, approximately 4 inches in diameter and 10 inches long. NMR gaussmeter recordings with time history indicated that the logarithm of the field decay rate varied linearly with the self-induced magnetic field. G.G.

N67-38787# Princeton, Univ., N. J. Plasma Physics Lab.
FIFTY-KILOGAUSS SUPERCONDUCTING MAGNET
J. File *In its* Plasma Phys. Lab. May 1967 p 362–369 refs
(See N67-38725 23-25)
(Grant NSF GP-579)

The design and construction of a superconducting magnet is described which consists of an inner and an outer layer of niobium–zirconium wire wound around a copper spool. The inner and the outer solenoids are energized separately to reach a field strength of 50 kG and homogeneity of 0.01% over a cylindrical volume 0.2 inch long by 0.2 inch diameter. Overwrapping the ends of the solenoid insured the homogeneity of the produced field. G.G.

N67-38792*# National Aeronautics and Space Administration. Electronics Research Center, Cambridge, Mass.
HETERODYNE OPERATION OF AVALANCHE PHOTODIODES
D. E. Sawyer Washington, NASA, Oct. 1967 11 p refs
(NASA-TN-D-4190) CFSTI: HC $3.00/MF $0.65 CSCL 09A

The effect of combining avalanche and heterodyne operations in a microwave photodiode is analyzed. The results show that, if $I_{P(o)}$ the dc photo current in the absence of multiplication, is below a critical value $I_{P(crit.)}$, the system S/N ratio increased with multiplication up to $M = M_{opt}$. Conversely, when $I_{P(o)} > I_{P(crit.)}$, multiplication will always cause the S/N ratio to decrease. Compared to the case of simple heterodyne operation ($M = 1$), the condition $M = M_{opt}$ for $I_{P(crit.)}$ in silicon photodiodes can yield large reductions in local oscillator (laser) power and diode dissipation without excessive degradation in noise-equivalent-power. Author

N67-38796*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
CONDUCTION MECHANISM IN ORGANIC SEMICONDUCTORS
Satish C. Mathur 26 Jul. 1967 58 p refs
(NASA-TM-X-53638) CFSTI: HC $3.00/MF $0.65 CSCL 20L

Several theories are examined for their usefulness in predicting the mobility of charge carriers in organic semiconductors. A modified band theory using Hückel molecular orbitals is shown to be applicable after rejecting other available theories. The complex molecular orbital calculations are simplified by the use of symmetry and group theory so that they can be programmed in reasonable time on a large computer. The calculations are applied to the complex hydrogen phthalocyanine crystal structure and compared to experimental measurements. Experimental measurements are described which provide the predicted order of magnitude and the predicted trend with temperature changes. Finally, a critique of the experimental method is made with recommendations for improvements. However, it is concluded that the molecular orbital theory is valid for predicting properties of organic semiconductors. Author

N67-38820# Michigan Univ., Ann Arbor.
A MEASUREMENT OF THE FINE AND HYPERFINE STRUCTURES OF THE 2^2P STATES OF ^7Li
Philip Di Lavore, III (Ph.D. Thesis) 1967 98 p refs
(Contract AT(11-1)-1112)
(COO-1112-117) CFSTI: HC $3.00/MF $0.65

An experimental determination is reported of the fine and hyperfine structures of the 2^2P term of ^7Li. The technique used for the measurements was that of level-crossing spectroscopy, wherein one takes advantage of the change of the angular distribution of the resonance fluorescence of atoms in a magnetic field which occurs when that field is such that two excited state Zeeman sublevels cross. NSA

N67-38827# Michigan State Univ., East Lansing. Dept. of Physics.
STUDY OF INTERACTIONS BETWEEN f-SHELL TRANSITION IONS IN NON-METALLIC CRYSTALS Annual Technical Progress Report, Oct. 1, 1966–Jun. 15, 1967
Edward H. Carlson 30 Jun. 1967 8 p refs
(Contract AT(11-1)-1533)
(COO-1533-6) CFSTI: HC $3.00/MF $0.65

The electrostatic, exchange, and magnetic dipole interactions between f-shell ions, particularly as manifested in the properties of magnetic ordered states (ferromagnetic and antiferromagnetic) arising from these interactions, were studied. Several rare earth halides ($PrCl_3$, $GdCl_3$, $ErCl_3$, $PrBr_3$, and DyF_3) were investigated using nuclear magnetic and quadrupole resonance techniques, and ac susceptibility. NSA

N67-38860# California Univ., Berkeley. Lawrence Radiation Lab.
KINETICS AND MECHANISMS OF THE DIFFUSION OF IRON AND NICKEL IN SINGLE CRYSTALS OF MAGNESIUM OXIDE
Stuart L. Blank (Ph.D. Thesis) Mar. 1967 141 p refs
(Contract W-7405-ENG-48)
(UCRL-17411) CFSTI: HC $3.00/MF $0.65

The diffusion kinetics in the Fe–MgO, NiO–MgO, and Fe_2O_3–MgO systems were investigated with particular emphasis placed on the relationship between atomistic mechanisms and structural changes. The existence of Fe^{3+} ions and their location in the lattice in the Fe–MgO (vacuum) and Fe_2O_3–MgO (air) systems were determined by the use of electron paramagnetic resonance, optical spectroscopy, and Moessbauer analyses. The location of Fe^{2+} in the systems was investigated using optical spectroscopy. The occurrence of Fe^{3+} ions in tetrahedral symmetry in the MgO lattice was associated with structural changes responsible for variations in the activation energy for diffusion in the Fe–MgO and Fe_2O_3–MgO systems. The presence of chemically created vacancies in all of the systems increased the diffusivities. The concentration vs penetration curves were obtained using the electron microprobe analyzer. Author (NSA)

N67-38869# Minnesota Univ., Minneapolis.
PRECIPITATION EFFECTS IN SEMICONDUCTORS Final Report

Richard A. Swalin Aug. 1967 5 p refs
(Contract Nonr-710(27)
(AD-657381)

A brief description is presented concerning the results obtained under terms of the Office of Naval Research contract. Reference is made to the previous technical reports and publications in which complete discussion of the various phenomena is presented. Nucleation of lithium precipitates in Si and Ge; theoretical calculations relating to diffusion in elemental semiconductors; thermal diffusion studies; self-diffusion in silicon; further precipitation studies. TAB

N67-38877# Massachusetts Inst. of Tech., Cambridge.
RESEARCH IN MATERIALS SCIENCE AND ENGINEERING Annual Report 1966–1967
Apr. 1967 450 p refs
(Contract AT(30-1)-1002)
(TID-23852) CFSTI: HC$3.00/MF$0.65

Research progress is reported on: chemical and solid state physics; electric, magnetic, and optical properties of materials and applications to devices; metallurgy and materials science; materials engineering; magnets; and instrumentation. NSA

N67-38925# Eagle-Picher Co., Miami, Okla.
RESEARCH IN PURIFICATION AND SINGLE GROWTH OF II–VI COMPOUNDS Interim Technical Report, 15 Apr. 1965–14 Apr. 1967
Richard H. Fahrig, George N. Webb, and Lloyd W. Brown
Wright-Patterson AFB, Ohio, ARL, Apr. 1967 61 p refs
(Contract AF 33(615)-2947)
(ARL-67-0070; AD-657045)

A process for the purification of cadmium metal by multiple treatment steps is described. Impurities in cadmium, as determined by emission spectrographic, mass spectrographic, and atomic absorption are given in tabular form. The preparation of various pure semiconductor materials of the Group II-VI compound type is discussed and tables of analytical data for each are included. The level of impurity concentration in synthesized cadmium sulfide was significantly lowered. Less than 1 part per million (atomic) total impurities was found by the mass spectrograph in two batches of CdS. The growth of crystals of pure II-VI compounds and mixtures of compounds from the melt is reported. Included are data concerning doping of melt grown crystals with various elemental dopants, and, in the case of some compound semiconductors, the maximum doping levels possible by this method. Author (TAB)

N67-39041# California Univ., La Jolla. Dept. of Physics.
TRANSPORT PROPERTIES OF THE "EXCITONIC INSULATOR". I: ELECTRICAL CONDUCTIVITY
Johannes Zittartz 4 Aug. 1967 30 p refs Sponsored in part by NSF
(Contract Nonr-2216(11))
(TR-47; AD-657439)

The d.c. conductivity of the excitonic insulator recently discussed in the literature is calculated in the semimetallic region. The calculations are based on recent work on the description of the excitonic phase in the presence of impurities. It is shown that the conductivity decreases below the transition temperature to the excitonic state. For low impurity concentrations the system acquires insulating properties. For higher concentrations of impurities the conductivity is still finite at $T = 0$. Thus, metallic properties prevail in the excitonic phase. It is pointed out that this behavior depends essentially on the form of the excitation spectrum of the system, i.e. the presence or absence of a gap. At the transition temperature the conductivity versus temperature curve has a finite slope. Author (TAB)

N67-39050# Japan Atomic Energy Research Inst., Tokyo.
ITINERANT ANTIFERROMAGNETISM IN CHROMIUM ALLOYS
S. Komura Jul. 1967 41 p refs
(JAERI-1137) CFSTI: HC$3.00/MF$0.65

Electrical resistivity and power neutron diffraction patterns for Cr–V, Cr–Mn and Cr–Mo binary alloys, as well as Cr–V–Mn ternary alloys, have been measured at various temperatures. Magnetic structure and corresponding physical quantities such as Neel temperature, magnetic moment, and wave vector of the spin density wave (SDW) state, were estimated. The results are compared with each other on the same scale of effective concentration; i.e., Mn concentration subtracted by V concentration in units of atomic percentage. The overall results, expressed as a unique function of effective concentration, show a good agreement between Cr–V, Cr–Mn binary alloys, and Cr–V–Mn ternary alloys. Main conclusions support the validity of rigid band approximation. The results are further discussed in terms of three SDW models for chromium: a free electron model, a single-band model, and a two-band model. The relationship of the Fermi surface to Brillouin zone boundaries is analyzed on the basis of extending Hume–Rothery's rule. A possible explanation for incommensurable-to-commensurable transition in Cr–Mn and Cr–V–Mn alloys as a function of electron concentration is proposed. Author

N67-39067*# Oklahoma State Univ., Stillwater.
SEEBECK EFFECT AND ELECTRICAL CONDUCTIVITY OF STANNIC OXIDE AS A FUNCTION OF TEMPERATURE AND AMBIENT PRESSURE Interim Report
James L. Rutledge (Ph.D. Thesis) Sep. 1967 127 p refs
(Grant NsG-609)
(NASA-CR-89345; SS-4) CFSTI: HC $3.00/MF $0.65 CSCL 20L

A study of the Seebeck effect and electrical conductivity of stannic oxide single crystals and of polycrystalline samples was made from 300°K to 1400°K. The primary objective was to determine the conduction mechanism at high temperatures and to evaluate the appropriate parameters. A secondary objective was to determine the parameters and mechanisms involved at lower temperatures. The high temperature conduction mechanism is shown to be intrinsic in character above 1000°K. The electronic conductivity is found to predominate over hole conduction by a factor of 7, while the effective masses of each type of carrier are similar. In addition the intrinsic band gap between 1000°K and 1400°K is found to be given by $E_g = 4.1 - 17 \times 10^{-4} T$ (eV). At lower temperatures the conductivity is found to be dependent upon pressure dependent thermal defects formed at high temperatures. In this region the mobility and effective mass of the electron are consistent with previously reported values. The thermoelectric power reached values as high as −1200 μv/deg at around 550°C. At temperatures below 500°C the conductivity appears to be pressure dependent via an oxygen chemisorption mechanism. A model for this behavior was proposed and a qualitative agreement between the model and experimental behavior was noted. Author

N67-39117# Iowa State Univ. of Science and Technology, Ames.
AMPLITUDE STUDIES OF THE DE HAAS-VAN ALPHEN EFFECT IN LEAD
Russell Allan Phillips (Ph.D. Thesis) May 1967 135 p refs
(Contract W-7405-ENG-82)
(IS-T-170) CFSTI: HC $3.00/MF $0.65

A detailed study of the amplitudes of the de Haas-van Alphen (dHvA) effect in lead is presented. These experiments were performed in a high-field pulse magnet employing a resonant filtering system. It was necessary to devise special techniques for the preparation of crystals of high perfection. Accurate effective mass values were measured for all the dHvA frequencies at symmetry directions. The results of the temperature-dependence of the harmonic and combination amplitudes indicate that

magnetic-interaction effects must be considered. By a generalization of Shoenberg's original approach to the magnetic-interaction problem, many of the observed features of the harmonic and combination amplitudes have been accounted for. Extensive studies of the magnetic-field dependence of the dHvA amplitudes were also made. The results of these measurements show that the Landau levels in pure lead crystals of high perfection are indeed very sharp. Author (NSA)

N67-39154# Boeing Scientific Research Labs., Seattle Wash. Plasma Physics Lab.
MICROWAVE EMISSION FROM NONEQUILIBRIUM PLASMAS IN InSb SUBJECT TO MAGNETIC FIELDS
Betsy Ancker-Johnson (Washington Univ., Seattle) Jun. 1967 72 p refs Sponsored in part by NSF
(DI-82-0823)

Contradictory information concerning the emission characteristics is reconciliated by means of a theory for the spatial distribution of plasmas during emission. It shows why some samples emit preferentially for $\vec{B} \| \vec{E}$, others for $\vec{B} \perp \vec{E}$, and still others for intermediate orientation. Under certain conditions the same sample can be made to emit during all orientations in consonance with the theory. The theory clarifies the various observed threshold dependencies. Why MHz resistance oscillations of two different natures attend emission under some conditions, and why under others such oscillations are totally absent is explained. The conflicting results concerning the spectral emission are attributed to faulty experimental techniques. Four emission characteristics and associated phenomena are described qualitatively: the spectrum, the polar dependencies, the sometimes attendant MHz resistance oscillations, and the threshold dependencies on $\vec{E}$ and $\vec{B}$. It is concluded that the role of the $\vec{B}$ in the emission is to place concentrated plasma within a radiation absorption length of a sample surface orthogonal to the direction of microwave propagation. It is argued that all observations of emission from InSb, at low and high electric fields, with and without magnetic fields, are caused by the same instability which is excited by the proper conditions of electric field and plasma density. Author

N67-39241# California Univ., La Jolla. Dept. of Physics.
TRANSPORT PROPERTIES OF THE "EXCITONIC INSULATOR". II: THERMAL CONDUCTIVITY
Johannes Zittartz 8 Aug. 1967 21 p refs Sponsored in part by NSF
(Contract Nonr-2216(11))
(TR-48; AD-657440)

The thermal conductivity of the excitonic insulator is calculated in the semimetallic limit. At low temperatures the main scattering mechanism is assumed to be due to impurities. Despite a recent claim of 'superthermal conductivity' of the system which can be described as a condensate of electron-hole pairs we find that the thermal conductivity is 'well behaved.' It is shown that the thermal conductivity in the semimetallic limit of the underlying two band model is almost identical to the thermal conductivity of a superconductor containing magnetic impurities as scatterers. The analogy stems from the fact that the thermodynamic properties in both cases are similar as was discussed recently. Author (TAB)

N67-39358# Boeing Scientific Research Labs., Seattle, Wash.
NANOSECOND RISETIME, HIGH POWER, VARIABLE DELAY DOUBLE PULSER WITH APPLICATION TO ELECTRON-HOLE PLASMAS
William P. Robbins (Washington Univ., Seattle), Robert M. Lantz, and Betsy Ancker-Johnson Aug. 1967 29 p refs Sponsored in part by NSF
(DI-82-0828)

A new double pulse system has been designed and tested which offers several advantages over previous methods of generating and delaying one squarewave pulse with respect to another. Characteristics of the new system are: fast rise and fall times (2 nanoseconds typical); high power pulses (150 V into 50 Ω); very low time jitter (less than 0.2% of pulse separation time); accurate repeatability of time delay (±1% typical); extremely wide range of time delay (nanoseconds to milliseconds); dc readout of the time separation of the two pulses accurate to ±1% and suitable for x-y pen recorders. A special summing junction circuit allows both pulses to be applied to the same load without power being split between the load and the other pulse generator, and also without the first pulse prematurely triggering the second pulse or affecting its amplitude. Some results obtained by applying this system to the study of electron-hole plasma decay are briefly presented. Author

27 PROPELLANTS

Includes fuels; igniters; and oxidizers. For basic research see: 06 Chemistry; and 33 Thermodynamics and Combustion. For related information see also: 28 Propulsion Systems.

N67-38150# Princeton Univ., N. J. Dept. of Aerospace and Mechanical Sciences.
A CRITICAL ANALYSIS OF ARC IMAGE IGNITION OF SOLID PROPELLANTS
M. Summerfield and T. J. Ohlemiller Jul. 1967 45 p refs
(Contract AF 49(638)-267)
(AFOSR-67-1534; Rept.-789; AD-655919)

The arc image furnace is used widely for evaluating solid propellant ignition characteristics, but the applicability of such data to rocket motors is questionable. In arc image testing, radiation replaces the normal conductive and convective heating modes that exist in rocket motor ignition; radiation interacts with the propellant in a basically different way. Thus, for example, because radiation is absorbed in depth, the ignition delay is sensitive to propellant opacity. In addition, radiation can cause subsurface disruption of the propellant. A physical model is proposed in which incident radiation penetrates the propellant and is absorbed, causing thermal and photochemical decomposition and a temperature increase. Oxidative reactions start either in the gaseous boundary layer or on the surface and, by thermochemical action, lead to a flame. The system of differential equations for this complete model is complicated and has not been solved. However, an equivalent model of simpler character is solved, and an equation is produced for the ignition time delay as a function of radiation intensity, pressure, and physico-chemical properties. The qualitative behavior of experimental radiative ignition data reported by Beyer and Fishman and by Bastress is explained by this theory. Author (TAB)

N67-38294*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
NORMAL GRAVITY SELF-PRESSURIZATION OF 9-INCH-(23 cm) DIAMETER SPHERICAL LIQUID HYDROGEN TANKAGE
John C. Aydelott Washington, NASA, Oct. 1967 49 p refs
(NASA-TN-D-4171) CFSTI: HC$3.00/MF$0.65 CSCL 21I

A nonventing 9-inch-(23 cm) diameter spherical container partially filled with liquid hydrogen was subjected to 21 quiescent self-pressurization tests. The container was subjected to various combinations of the variables percent filling, heat-transfer rate, and either top heating, bottom heating, or uniform heating. The

pressure-rise rate in the container was primarily a function of the heating configuration with the percent filling and heat-transfer rate playing a secondary role. An analysis is presented for determining the resulting energy distribution within the hydrogen container. Appreciable energy transfer from the vapor to the liquid causing evaporation and liquid heating occurred during both the uniform heating and top heating tests. Author

N67-38400*# Atlantic Research Corp., Alexandria, Va.
LIQUID PROPELLANT TESTS IN A VACUUM CHAMBER Final Report, 7 Jun. 1966–7 Jun. 1967
John A. Simmons, Ralph D. Gift, Jack M. Spurlock, and Jaydee M. Miller 21 Jul. 1967 83 p refs
(Contract NAS9-6105)
(NASA-CR-65749) CFSTI: HC $3.00/MF $0.65 CSCL 21I

The reactivity and expansion characteristics of Aerozine-50 and nitrogen tetroxide, released instantaneously in bulk quantities into low-pressure environments ranging from 1×10^{-5} to 1 atm, are described. Experiments were performed in a large vacuum chamber by breaking thin-wall glass spheres, each containing 300 ml of one of the propellants. After breakage of the spheres, both high-speed motion pictures and pressure records (by piezoelectric transducers) showed that the liquids dispersed by boiling at the exposed surface and the resulting cloud of vapor and drops expanded symmetrically. At ambient pressures of 0.1 atms and above, the normal hypergolically ignited combustion or mild explosion occurred approximately 5 milsec after the release (the spheres were 0.5 inch apart). At ambient pressures below 0.01 atm, normal hypergolic ignition did not occur. Instead, a mist of an unknown compound (s) formed and detonated 70 to 180 milsec after the release. The detonation occurred when the pressure was a few torr above the original ambient level and apparently was initiated by one of the warm metal surfaces of the steam-ejector pumping system. Author

N67-38655*# Stanford Research Inst., Menlo Park, Calif. Polymer and Propulsion Sciences Div.
EVALUATION OF OZONE DIFLUORIDE AS A LIQUID PROPELLANT ADDITIVE Final Report
A. B. Amster, E. L. Capener, L. A. Dickinson, R. J. Kier, M. McCormick et al 1 Dec. 1966 96 p refs
(Contract NAS3-4187; SRI Proj. 5075)
(NASA-CR-54833) CFSTI: HC $3.00/MF $0.65 CSCL 21I

The hypergolicity of O_3F_2 at the saturation point in liquid oxygen with liquid and gaseous hydrogen is critically dependent upon the temperature of the combustion chamber. When this temperature is above 150°K, pressure, total injected weight ratio of oxidizer to fuel, and injector type were the primary variables of importance. The preparation, mixing, and use of solutions of O_3F_2 in liquid oxygen is reviewed. The storage life of these solutions at 90°K is not expected to exceed one month. Author

N67-39029*# Stanford Research Inst., Menlo Park, Calif.
CORRELATION BETWEEN SOLID PROPELLANT MECHANICAL PROPERTIES AND EXPLOSION EFFECTS Final Report, 1 Jul. 1966–30 Jun. 1967
A. B. Amster, R. W. Woolfolk, and G. M. Muller 31 Jul. 1967 90 p refs
(Contract NAS7-480; SRI Proj. FRU-6150)
(NASA-CR-89321) CSCL 21I

The relation between solid propellant mechanical properties and explosion effects is examined. For a selected geometry an imposed shock decays exponentially. Only a very small fraction of the propellant lost in the model blast contributes to the blast wave, and flash radiographs show an anomalous structure of the pressure wave traveling through the propellant. Several points on the Hugoniot of the selected propellant have been obtained, but these do not account for this anomaly. Author

28 PROPULSION SYSTEMS

Includes air breathing, electric, liquid, solid, and magnetohydrodynamic propulsion. For nuclear propulsion see: 22 Nuclear Engineering. For basic research see: 23 Physics, General; and 33 Thermodynamics and Combustion. For applications see: 31 Space Vehicles. For related information see also: 27 Propellants.

N67-38103# RAND Corp., Santa Monica, Calif.
THE TWO-STAGE SOUNDING-ROCKET PROBLEM
Russell D. Shaver Aug. 1967 36 p refs
(P-3490; AD-657003)

The paper addresses the problem of determining the appropriate history of the thrust of a rocket engine that produces maximum altitudes for a two-stage-rocket launch vehicle. Simplifying assumptions, for example, that the earth is flat, have been made and rules for optimal thrust arcs have been derived. Effects of changes in vehicle characteristics at staging, including the vehicle drag coefficient and the rocket engine characteristics, are investigated. Significant alterations from previously analyzed single-stage sounding-rocket trajectories are possible. The occurrences of intermediate coasting arcs, intermediate variable-thrust arcs, and up to five control switches are all characteristics unique to the two-stage problem. Although these differences will be minimized by the inclusion of realistic atmospheric drag profiles, they will probably exist if the lift-off acceleration of the sounding rocket is high. Author (TAB)

N67-38245# Hydronautics, Inc., Laurel, Md.
AIRBOAT NOISE REDUCTION AND IMPELLER DESIGN FOR WATERJET PROPULSION SYSTEMS
Dinshaw N. Contractor and J. Otto Scherer Jul. 1967 97 p refs
(Contract Nonr-5018(00))
(TR-532-1; AD-657187)

The report deals with problems encountered in two different forms of propulsion used for shallow draft boats. The first part of the report describes the program undertaken to reduce the radiated noise levels around a boat propelled by means of an airscrew. A new propeller was designed to reduce the radiated noise while providing the same or higher thrust. A shroud was designed to reduce the propeller thrust loading and hence decrease the radiated noise level. An extensive series of noise and thrust performance tests was carried out, in which the number of blades and blade pitch were varied. The results of these tests indicated that the new propeller with 4 blades and a 14-degree pitch, operating in the shroud provided more thrust and was quieter than the original wooden propeller. The second part of the report concerns the design of impellers for use in water jet propulsion system for shallow draft boats. The impellers in a commercial water jet system used by the Army did not perform as anticipated. The report describes the design of a new impeller and guide vanes to replace those in the commercial unit. Author (TAB)

N67-38637 France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.
FRENCH RESEARCH ON ELECTRIC PROPULSION—PRESENT STATUS AND PROSPECTS FOR DEVELOPMENT [RECHERCHES FRANCAISES SUR LA PROPULSION ELECTRIQUE ETAT ACTUEL ET PERSPECTIVES D'AVENIR]
Emile Le Grives 1967 10 p refs Presented at the AIAA Elec. Propulsion and Plasmadyn. Conf., Colorado Springs, 11–13 Sep. 1967
(ONERA-TP-503(1967))

During the last decade, several laboratories have carried on research in the field of electric propulsion, more on fundamental

aspects of plasmadynamics than on developments towards specific applications. Most of the present work is now on traveling wave accelerators, a rail type plasma gun, and mercury ion thrustors. A recently devised constricted arc-jet working at subatmospheric pressure is used for high speed/high altitude flight simulation. Previous tests of this type of thrustor with hydrogen as a propellant were carried out successfully. Recent advances in solar cell technology open a new prospect to solar electric propulsion applications in the near future. In the case of missions of long duration, high values of the total impulse, such as wanted for solar probes, or substantial mass savings in propellant, which are needed for satellite station keeping, will be available with solar powerplants delivering 20 W/kg or more. Author

N67-38922* General Electric Co., Lynn, Mass. Flight Propulsion Div.
SINGLE STAGE EXPERIMENTAL EVALUATION OF HIGH MACH NUMBER COMPRESSOR ROTOR BLADING. PART 4: PERFORMANCE OF ROTOR 2D
K. W. Krabacher and J. P. Gostelow 6 Oct. 1967 85 p refs
(Contract NAS3-7617)
(NASA-CR-54584; GER-67FPD276) CSCL 21E

A 1400 foot per second tip speed rotor with a 0.5 hub-tip radius ratio and double-circular-arc blade sections, designed to deliver a total pressure ratio of 1.76 and a rotor adiabatic efficiency of 0.837 at a flow of 215.49 lb/sec, was tested with uniform inlet flow. For a point at design speed, judged to have adequate stall margin for engine operation, a rotor total pressure ratio of 1.677 and an adiabatic efficiency of 0.854 at a flow of 226.0 lb/sec were actually achieved. Author

N67-39180 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF THE INFLUENCE ON GAS TURBINE EFFICIENCY OF ADMISSION INTO ITS BLADING OF AIR COOLING THE WHEELS AND HOUSING OF THE TURBINE [ISSLEDOVANIYE VLIYANIYA NA KOEFFITSIENT POLEZNOGO DEYSTVIYA GAZOVOY TURBINY VPUSKA VEYE PROTOCHNUYU CHAST' VOZDUKHA, OKHLAZHDAYUBHCHEGO DISKI I KORPUS TURBINY]
Ye. N. Bogomolov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 123–137 refs (See N67-39169 23-32)

In this article the author attempts an approximate theoretical investigation of the gas flow in a turbine with cooling air introduced into the turbine from the direction of the boundary surface of the flow section and analyzes the effect of turbine air cooling on its efficiency on the basis of the formulas derived. In this connection, the author also considers the losses due to the formation of a dead or "stagnant" zone between the wall of the flow section and the internal boundary of the stream of cooling air. The flow contour of this dead or "stagnant" zone is analyzed. Author

N67-39186 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INVESTIGATION OF A RADIAL-AXIAL TURBINE WITH LOW BLADE HEIGHTS AND LARGE CLEARANCES [ISSLEDOVANIYE RADIAL'NO-OSEVOY TURBINY S MALYMI VYSOTAMI LOPATOK I S BOL'SHIMI ZAZORAMI]
L. N. Odivanov and A. P. Tunakov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 185–200 refs (See N67-39169 23-32)

A radial-axial (centripetal) turbocompressor turbine, the TKR-14 (air trial efficiency = 0.65), was developed in order to facilitate the study of the effect of various factors on the operation of such turbines. The author reviews the recommendations that were made with a view toward increasing the efficiency of this experimental model. Subsequently, the running assembly was re-designed to permit the direct measurement of the internal power (moment) of the turbine when operating with blades of small height. The modifications made on this model in accordance with the recommendations are discussed in detail and it is shown that efficiency was increased 16% to 87%, despite the small size of the turbine. A diagram is given, showing the section between the inlet and outlet valve through which the steam passes (the "flow-through section") for various blade heights. Author

N67-39193 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
INFLUENCE OF ADJOINT VOLUMES ON CHARACTERISTICS OF COMPRESSOR AND VIBRATION STRESSES OF BLADES [VLIYANIYE PRISOYEDINENNYKH OB'YEMOV NA KHARAKTERISTIKI KOMPRESSORA I VIBRATSIONNYYE NAPRYAZHENIYA LOPATOK]
N. I. Sapozhnikov *In its* News of Inst. of Higher Learning. Astron. Eng. 27 Apr. 1967 p 259–263 ref (See N67-39169 23-32)

When designing axial compressors, the flow-through section (the section between the inlet and outlet valves) is occasionally made to communicate through apertures or windows in the housing with cavities. These latter are called add-on cavities, and their purpose is to tap air in order to heat parts which might otherwise be subject to icing and to provide manifold pressure and cabin heating. It was experimentally established that these cavities lower the pumping limit and, in certain instances, affect the vibrations of the working and guiding blades. In order to illustrate the effect of an add-on cavity on the pumping limit, the author considered the results of a test of the same compressor characterized by the following assembly elements: (a) with smooth flow-through section; (b) with two series of apertures for air transfer (apertures covered by ribbons from the external part of the casing); and (c) with an air transfer body forming a ring-shaped cavity above each row of apertures. Author

29 SPACE RADIATION

Includes cosmic radiation; solar flares; solar radiation; and Van Allen radiation belts. For related information see also: 13 Geophysics; and 24 Physics, Atomic, Molecular, and Nuclear.

N67-38135# Michigan Univ., Ann Arbor. Dept. of Physics.
A COSMIC RAY PROGRAM FOR THE STUDY OF STRONG INTERACTION PHYSICS IN THE RANGE OF 100–1000 GeV
Lawrence W. Jones Jun. 1967 29 p refs Presented at the 10th Intern. Conf. on Cosmic Ray Phys.
(Contract Nonr-1224(23))
(Rept.-03108-30-T; TR-30; AD-655908)

There has been continuing discussions on the possibility of erecting an ambitious cosmic ray experimental facility at mountain altitudes directed toward the study of strong-interaction physics in the energy range of 100 to 1000 GeV. Several specific objectives for such a facility are: that nucleon interactions be studied on free protons, a liquid hydrogen target; that the identity of the incident particle be ascertained and that momentum analysis of the incident and reaction products be precise to a few percent; and that the total number of events collected at energies well above existing accelerator energies be over 10,000 per year. The report is a study of the technical and scientific questions encountered in the design of such a facility. Author (TAB)

N67-38201*# Israel Program for Scientific Translations, Ltd., Jerusalem.

COSMIC RAYS AND PROBLEMS OF SPACE PHYSICS [KOSMICHESKIE LUCHI I PROBLEMY KOSMOFIZIKI]

Yu. G. Shafer, ed. 1967 353 p refs Transl. into ENGLISH of the Proc. of the All-Union Conf. on the Space Phys. Aspects of Cosmic-Ray Res., Yakutsk (USSR), Aug.–Sep. 1962 Published for NASA and NSF

(NASA-TT-F-428; TT-67-51365) CFSTI: HC $3.00/MF $0.65 CSCL 20H

Conference papers are presented on cosmic ray investigations, and include topics on showers and components; seasonal, diurnal, and secular variations; interactions with geomagnetic and interplanetary magnetic fields; and instrumentation. For individual titles see N67-38202 to N67-38234.

N67-38202*# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE PRIMARY COMPONENT OF COSMIC RADIATION

V. L. Ginzburg, L. V. Kurnosova, V. I. Logachev, L. A. Razorenov, and M. I. Fradkin *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 4–19 refs (See N67-38201 23-29)

Experimental data obtained by various types of apparatus are reviewed. The chemical composition of the cosmic rays is emphasized. Measurements of the rigidity spectra of different nuclei are discussed, and integral and differential energy spectra are graphed. The importance of determining the relative abundance of nuclei for investigating the origin of cosmic rays is indicated. Charge distribution and flux measurements of nuclei are described. The composition of solar cosmic rays and recent observations of nuclei of solar observations are summarized. The electron and positron components of cosmic rays are mentioned. N.E.N.

N67-38203*# Israel Program for Scientific Translations, Ltd., Jerusalem.

THE NEUTRINO AND ITS IMPORTANCE IN ASTROPHYSICS

Bruno Pontecorvo *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 20–40 refs (See N67-38201 23-29)

The essential role that neutrinos have in macroscopic phenomena is discussed. The known properties of neutrinos are reviewed, and unsolved problems involving interactions of high energy neutrinos with other elementary particles are investigated. Observations on the interactions are presented. The emission of neutrinos from the sun and the emission of neutrino–antineutrino pairs during the electron–neutrino interaction are described. The parts played by neutrinos in neutral currents, and in astrophysics and cosmogony are outlined. The neutrino luminosity is reported to exceed the photon luminosity for heavy stars with high temperatures and densities. Neutrinos and antineutrinos are considered to be important factors in the evolution of white dwarfs and in the explosion dynamics of supernovae. N.E.N.

N67-38204*# Israel Program for Scientific Translations, Ltd., Jerusalem.

APPLICATION OF AN UNIDIMENSIONAL-DIFFUSION MODEL TO THE PROPAGATION OF SOLAR COSMIC RAYS

G. F. Krymskii *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 41–44 refs (See N67-38201 23-29)

An expression is developed to describe the unidimensional diffusion within a bounded layer located inside the earth's orbit. Curves of the intensity as a function of time for solar flares of 23 February 1956 and 4 May 1960 are presented, and the theoretical data are found to fit the experimental data satisfactorily. It is concluded that the results agree with theory of radial interplanetary magnetic field, twisted by solar rotation. N.E.N.

N67-38205*# Israel Program for Scientific Translations, Ltd., Jerusalem.

A SEARCH FOR HIGH-ENERGY PHOTONS FROM DISCRETE SOURCES OF COSMIC RADIO EMISSION

A. E. Chudakov, V. L. Dadykin, V. I. Zatsepin, and N. M. Nesterova *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 45–47 refs (See N67-38201 23-29)

An experiment to detect photons from radio sources by photomultipliers and the results obtained are briefly described. The sources observed were Cassiopeia A, Taurus A, Cygnus A, Virgo A, and other less powerful sources. No sharp rise in the counting rates was noted when the source passed through the viewing angle of the telescopes, and the flux did not exceed 10^{-11} photons/cm^2. Contradictions within the data and between data and hypotheses are discussed. N.E.N.

N67-38206*# Israel Program for Scientific Translations, Ltd., Jerusalem.

STUDIES OF VARIATIONS IN THE PRIMARY COSMIC RADIATION

Yu. G. Shafer *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 48–59 refs (See N67-38201 23-29)

Recent and proposed measurements of the spatial and temporal variations in the intensity, energy spectrum, and chemical compositon of primary cosmic rays are reviewed. Observations of high energy and low energy particles are covered, and difficulties encountered in obtaining measurements in the upper atmosphere and the magnetosphere are indicated. Present and future instruments for specific experiments are mentioned, and the types of data expected to be found are described. N.E.N.

N67-38208*# Israel Program for Scientific Translations, Ltd., Jerusalem.

EXTENSIVE AIR SHOWERS OF COSMIC RADIATION

S. I. Nikol'skii *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 86–102 refs (See N67-38201 23-29)

Data concerning cosmic ray showers obtained from recent experiments, and their implications are reviewed. Lateral distribution, the total number of charged particles, and the number spectrum in extensive showers are discussed. Lateral distributions of muons are graphed and fluctuations in their relative number are described. Data on the energy fluxes of different components is presented. The energy spectrum and ways of investigating anisotropy of the primary radiation are also described. N.E.N.

N67-38209*# Israel Program for Scientific Translations, Ltd., Jerusalem.

PRIMARY COSMIC RADIATION IN THE ULTRA HIGH-ENERGY RANGE AND EXTENSIVE AIR SHOWERS

S. N. Vernov, V. I. Solov'eva, B. A. Khrenov, and G. B. Khristiansen *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 103–111 refs (See N67-38201 23-29)

The main results of the total data obtained on cosmic air showers by Moscow State University during 1960 and 1961 are discussed. The special significance of recording fluxes of high energy muons is indicated. The sharp variation in the energy spectrum is analyzed. Particle distributions for showers with different number of particles are investigated. Isotropy of the primary radiation at extremely high energies is also considered. N.E.N.

N67-38212*# Israel Program for Scientific Translations, Ltd., Jerusalem.

COSMIC-RAY BURSTS

A. I. Kuz'min and G. F. Krymskii *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 133–139 refs (See N67-38201 23-29)

A brief analysis of the frequency distributions, and of the temporal and energy characteristics of bursts is presented. The

frequency and temporal distributions are discussed, and the data are graphed. Among the findings are that the largest number of cosmic ray bursts are caused by chromospheric flares on the western side of the solar disk, and that the bursts are always observed during or after terrestrial magnetic storms. The intensity distribution and behavior, energy spectrum of solar particle flux, and the duration of burst as a function of chromospheric flare position are described. A model of the interplanetary magnetic field is summarized. N.E.N.

N67-38213*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE EFFECT ON COSMIC RAYS OF A VARIATION IN THE GEOMAGNETIC THRESHOLDS
A. I. Kuz'min and G. F. Krymskii *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 140–143 refs (See N67-38201 23-29)

The planetary increases in cosmic ray intensity during large geomagnetic storms, which are unrelated to solar variations are discussed. It was found that the geomagnetic threshold variation has little effect on the cosmic rays for the majority of magnetic storms. The model of Obayashi and Hakura is briefly described and is considered to be the most correct model. The effect of lunar daily variation in terms of a tidal action of the moon upon the magnetosphere is investigated. It is felt that the lunar daily variations are real but do not represent lunitidal fluctuations of the magnetosphere. N.E.N.

N67-38214*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE VARIATION IN COSMIC-RAY INTENSITY AT THE TIME OF A FORBUSH DECREASE
L. I. Dorman, E. V. Kolomeets, L. V. Kozak, V. T. Pivneva, and G. A. Sergeeva *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 144–155 (See N67-38201 23-29)

Detailed data are presented on eight instances of intensity during a Forbush decrease. Graphs are included of the cosmic ray neutron intensity variation, horizontal geomagnetic field component variation, and the intensity increase at the time of a Forbush decrease for each period. The neutron and hard component intensities are also considered as a function of cutoff rigidity and geographic longitude. N.E.N.

N67-38215*# Israel Program for Scientific Translations, Ltd., Jerusalem.
COSMIC RAYS IN JULY 1961
A. I. Kuz'min, G. F. Krymskii, G. V. Skripin, N. P. Chirkov, Yu. G. Shafer et al *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 156–163 refs (See N67-38201 23-29)

The general sequence of events during the month are outlined, and the intensity drops on the 13th and 18th are described in greater detail. The first intensity drop is related to the corpuscular stream arrival causing a geomagnetic storm. The second drop indicated that the earth entered a new plasma cloud. The rotation of the anisotropy vector during the 14th and 15th is discussed. It was determined that: (1) The amplitude and spectrum of the Forbush decrease on 13 July depend on the direction of the arriving radiation. (2) The particles of the burst on 18 July spread via diffusion in an irregular magnetic field. (3) The spectrum of the cosmic ray increase on 18 July was comparatively hard. N.E.N.

N67-38216*# Israel Program for Scientific Translations, Ltd., Jerusalem.
SOME RESULTS OF AZIMUTHAL MEASUREMENTS OF COSMIC-RAY VARIATIONS AT YAKUTSK
A. I. Kuz'min, G. V. Skripin, S. N. Druzhinin, G. F. Krymskii, and P. A. Krivoshapkin *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 164–172 refs (See N67-38201 23-29)

Results of a statistical analysis of observations made during the IGY and the IQSY. The geomagnetic field measurements and the recordings of the hard cosmic ray component intensity are mentioned. The solar diurnal variations are described and the first harmonics of the mean diurnal variations for the whole two year period and for the meson components are graphed. The properties of the diurnal variations of the cosmic rays during days of magnetic disturbances are described. Several cosmic ray bursts were recorded, and are briefly mentioned. N.E.N.

N67-38217*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE CONTRIBUTION OF SOLAR PARTICLES TO THE DIURNAL VARIATION OF THE NEUTRON INTENSITY
G. V. Skripin, G. F. Krymskii, and L. P. Boltrushko *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 174–179 refs (See N67-38201 23-29)

Studies of the cosmic rays from small solar flares and their contribution to the neutron component intensity are reviewed. Data on the neutron intensity at the time of solar flares and the average solar flare effect are graphed. Contradictions in the results are discussed, and reasons for the contradictory results are suggested. N.E.N.

N67-38218*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE EAS FREQUENCY DURING PERIODS OF VARIOUS EFFECTS IN THE INTENSITY OF INTERMEDIATE-ENERGY COSMIC RAYS
N. N. Efimov, M. M. Atakova, T. A. Egorov, D. D. Krasil'nikov, S. V. Maksimov et al *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 180–183 refs (See N67-38201 23-29)

The 27-day variations in cosmic ray shower intensity were recorded, and were studied in relation to the existence of a 27-day recurrence period for atmospheric conditions. It is felt that the results imply that the lateral distribution function is produced not only over the last cascade units of the shower path but also over higher layers of the atmosphere. Similar recordings made during Forbush decreases are also described. N.E.N.

N67-38219*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE UNUSUAL PHENOMENA RELATED TO THE COSMIC-RAY VARIATIONS IN DECEMBER 1957
N. P. Chirkov, A. I. Kuz'min, G. F. Krymskii, G. V. Shafer, and V. A. Filippov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 197–205 refs (See N67-38201 23-29)

The anisotropy in the period 18–23 December and the rotation of the anisotropy source are discussed. The observations are extensively graphed, and a tentative explanation is presented. It is considered that the earth entered for forepart of a corpuscular flux with an average velocity of 0.8×10^8 cm/sec. The unusual diurnal variations and the unusual onset of the Forbush effect are related to the action of the interplanetary magnetic field on the cosmic rays. It is suggested that the explanation of the anomalous phenomena of 23 December lies in the interaction between two magnetized or corpuscular fluxes, acting as independent systems. N.E.N.

N67-38220*# Israel Program for Scientific Translations, Ltd., Jerusalem.
IONIZATION-BURST VARIATIONS
N. P. Chirkov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 206–210 refs (See N67-38201 23-29)

Ionization bursts and the meson component were recorded simultaneously, and a four-year rhythmic variation was found for both bursts and mesons. Seasonal variations in the number of bursts were also noted. Preliminary analysis indicates that the secular

variations in the number of bursts are accompanied by analogous secular changes in the temperature of the upper layers of the atmosphere. N.E.N.

N67-38221*# Israel Program for Scientific Translations, Ltd., Jerusalem.
RHYTHMIC TRENDS IN THE SECULAR VARIATIONS OF COSMIC-RAY INTENSITY
N. P. Chirkov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 211–215 refs (See N67-38201 23-29)

Data from the Carnegie Institute compiled over a 20-year period were studied to determine the type of variations existing in cosmic ray intensities. The data were corrected for secular variations. An annual and a four-year rhythmic variation were found. Peculiar annual variations in the relative sunspot number were also noted, which have a four-year rhythm. It is thus concluded that solar activity has a four-year period. Annual variations in the neutron component are also mentioned. N.E.N.

N67-38222*# Israel Program for Scientific Translations, Ltd., Jerusalem.
CORRELATION OF THE FREQUENCY OF LARGE IONIZATION BURSTS WITH THE 11-YEAR SOLAR-ACTIVITY CYCLE
D. D. Krasil'nikov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 216–220 refs (See N67-38201 23-29)

Contradictory data on large ionization bursts observed during continuous recordings of intensity variations of the hard cosmic ray component are presented and discussed briefly. Data which indicate both a positive and a negative correlation with the 11-year cycle are described. A statistical analysis of instrumental errors is summarized. It is considered that a considerable portion of burst frequency variations correlating with the 11-year solar cycle are real and also that spurious 11-year variations are possible. N.E.N.

N67-38223*# Israel Program for Scientific Translations, Ltd., Jerusalem.
OBSERVATIONS OF THE ULTRALOW-FREQUENCY (ULF) RADIATION OF POLAR AURORAE
E. F. Vershinin and E. A. Ponomarev *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 221–231 refs (See N67-38201 23-29)

Data from visual observations and electrophotometer observations of the whole sky, from vertical radiosonde observations of the ionosphere, and from horizontal geomagnetic field component measurements are discussed. The results indicate a close correlation between visually observed polar aurorae, disturbances of the geomagnetic field, the appearance of a sporadic E layer, and ULF radiation. The interaction of ULF waves with the ionosphere is also discussed, and equations are developed to express the characteristics of ULF propagation. N.E.N.

N67-38227*# Israel Program for Scientific Translations, Ltd., Jerusalem.
A COMPARISON BETWEEN THE DIURNAL VARIATIONS OF THE GEOMAGNETIC FIELD AND THE THE CORRESPONDING VARIATIONS OF COSMIC-RAY INTENSITY
A. A. Danilov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 255–265 refs (See N67-38201 23-29)

The regularities in the solar disturbed day variations and the corresponding seasonal variations are considered, and a comparison is made with the intensity variations of the cosmic ray neutron component. The variations are plotted and described, and the distinctive features are noted. It was concluded that: (1) The magnetic field variations during disturbed days are caused mainly by systems of electric currents situated in the polar regions. (2) Seasonal shifts in the diurnal variation of cosmic ray neutron component intensity occurred, and correlate well with the corresponding seasonal shifts of the horizontal component of the geomagnetic field. N.E.N.

N67-38228*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE STUDY OF SHORT-PERIOD VARIATIONS AND MICROVARIATIONS IN COSMIC-RAY INTENSITY BY MEANS OF SINGLE SCINTILLATION COUNTERS
A. T. Abrosimov and Ye. L. Blokh *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 266–276 refs (See N67-38201 23-29)

The necessity of new instrumentation to observe the microvariations is emphasized, and recent instruments are reviewed. Equipment for studying short period variations and microvariations are described and include the scintillation telescope, the supermonitor consisting of 4 large neutron pulse ionization chambers filled with BF_3 gas, and plastic scintillators. Requirements for photomultipliers used in scintillation counters, and equipment for observing the operational stability of the photomultipliers are described. Methods of stabilizing the scintillation counters are indicated. N.E.N.

N67-38231*# Israel Program for Scientific Translations, Ltd., Jerusalem.
THE USE OF DELTA ELECTRONS TO DETERMINE THE NATURE AND ENERGY OF CHARGED PARTICLES
I. Ya. Chasnikov *In its* Cosmic Rays and Probl. of Space Phys. 1967 p 286–289 refs (See N67-38201 23-29)

Data using δ electrons are reviewed for different primary particles, nuclear emulsions, and photographic plates. A theoretical expression is presented for the number of δ electrons with energies between given limits and produced by a rapid charged particle with given charge. The kinematics of the elastic interaction between particle and atomic electron of the emulsion materials is also considered. N.E.N.

N67-38349*# Volt Technical Corp., Washington, D. C.
DETERMINATION OF THE FRAGMENTATION PARAMETERS OF THE MULTI-CHARGE COMPONENT OF PRIMARY COSMIC RAYS [OPREDELENIYE PARAMETROV FRAGMENTATSII MNOGOZARYADNOY KOMPONENTY PERVICHNYKH KOSMICHESKIKH LUCHEY]
Yu. F. Gagarin and N. S. Ivanova 13 Oct. 1967 9 p refs Transl. into ENGLISH from Kosmich. Issled. (Moscow), v. 5, no. 3, 1967 p 450–455
(Contract NAS5-12487)
(NASA-CR-88971; ST-CR-NP-10656) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The fragmentation parameters of heavy nuclei have been obtained on the hydrogen emulsion by utilizing nuclear emulsions exposed at 300 km altitude, and sorting the interactions of heavy nuclei of cosmic rays with a number ≤ 1 of black and gray rays related to target nucleus. The possibilities of transition (fragmentation parameters) of nickel nuclei to groups H ($Z \geq 10$); H_1 ($Z = 20 \div 28$); H_2 ($Z = 16 \div 19$); H_3 ($Z = 10 \div 15$); M ($Z = 6 \div 9$); and L ($Z = 3 \div 5$) were obtained by studying the interactions of protons with energy 10 BeV with nuclei of nickel, introduced into the emulsion in the form of spherical particles of $\approx$ 9 mkm diameter. Author

N67-38397*# Arizona Univ., Tucson.
THE ANTIPROTON COMPONENT OF THE PRIMARY COSMIC RAY FLUX
J. R. Wayland and T. Bowen [1967] 42 p refs
(Grant NGR-03-002-071)
(NASA-CR-88977) CFSTI: HC $3.00/MF $0.65 CSCL 20H

The solution of a Fokker–Planck diffusion equation for the diffusion and acceleration of cosmic rays is given. A time-independent solution is obtained by assuming that the contributions to the

present intensity of particles injected at a uniform rate during all past times is equivalent to summing the intensities over all future time of particles injected at a given time. Continuous deceleration and fluctuations in acceleration are used to explain the energy spectrum. This gives a general expression for a power law spectrum in which the exponent varies as $\gamma = 0.09\,h\,(E/m) + 0.90$, thus allowing a very good fit to the experimental energy spectrum. A previously developed expression for the production of antiprotons is applied to obtain an injection spectrum. This and the above solutions are then applied to three extreme cases of possible origin. The resulting antiproton spectra depend upon whether the material encountered by primary cosmic ray protons is mostly inside or outside the regions of acceleration. Author

N67-38411# Kiel Univ. (West Germany). Institut fuer Reine und Angewandte Kernphysik.
THE SEA-LEVEL MUON SPECTRUM AND CHARGE RATIO AT A ZENITH ANGLE OF 45° [DAS MUONEN-SPEKTRUM UND DAS LADUNGSVERHAELINIS AUF MEERESHOEHE UNTER EINEM ZENITWINKEL VON 45°]
R. D. Andresen Apr. 1967 26 p refs In GERMAN; ENGLISH summary
(BMwF-FBK-67-29)

The momentum distribution and charge ratio of the penetrating component of the cosmic radiation at sea level have been determined over the range 0.2 to 20 GeV/c at a zenith angle of 45° in the eastern and western azimuths. For these measurements a magnetic spectrograph has been used, based on spark chamber technique for track location. Author (NSA)

N67-38497*# Volt Technical Corp., Washington, D. C.
OBSERVATIONS OF L α-EMISSION FROM MILKY WAY
V. G. Kurt 9 Oct. 1967 5 p refs Transl. into ENGLISH from Astron. Tsirkuliar Akad. Nauk SSSR (Kazan), v. 439, 18 Aug. 1967
(Contract NAS5-12487)
(NASA-CR-88983; ST-SPC-IGA-10652) CSCL 20H

The results of ultraviolet radiation observations during the flights of AIS Venera 2 and 3 are briefly described. The ultraviolet was registered in the 1050–1340 Å and 1225–1340 Å bands. In the first band, the radiation was determined mainly by the scattering of solar L_α quants on neutral interplanetary hydrogen. The intensity was about 2.5×10^{-5} erg/cm^2 sec ster according to Venera 3 data and 6×10^{-5} erg/cm^2 sec ster from Venera 2 data. For the second band, the counting rate was determined mainly by cosmic ray pulses. The intensity was approximately 2×10^{-7} erg/cm^2 sec ster. The ratio of brightness in the Milky Way band near 1300 Å to that near 5500 Å is approximately 10^{-2}, which is substantially lower than usual estimates. N.E.N.

N67-38678*# Iowa State Univ. of Science and Technology, Ames. Dept. of Physics and Astronomy.
THE SOLAR X-RAY FLARE OF 7 JULY 1966
J. A. Van Allen Jul. 1967 32 p refs
(Contracts NAS5-9076; Nonr-1509(06))
(NASA-CR-89262; Rept.-67-35; AD-657186) CSCL 20H

By means of a mica window Geiger-Mueller tube on earth satellite Explorer 33, a major solar x-ray flare was observed with 81.8 sec time resolution on 7 July 1966. The flare had its onset at 00:23, its maximum intensity at 00:42, and a total duration of 200 minutes. The maximum energy flux was 0.03 ergs/sq cm sec and the time integrated flux was 97 ergs/sq cm (2 < lambda < 12 deg. A). Assuming equal intensity over 2 pi-steradians at the sun, the total emission in this wave length band was 1.4 x 10 to the 29th power ergs and the maximum surface luminosity of the sun was 2.9 x 10 to the 6th power ergs/sq cm sec or 4.5 x 10 to the -5 power of the whole radiant luminosity of the average solar surface. Charged particles began to arrive at the satellite at 00:58, or 35 minutes after the first detection of the x-ray enhancement, and remained in the interplanetary system for at least ten days thereafter. The intensity-time curve of the soft x-rays is compared with those of 2700 MHz solar radio noise flux and of ionospheric absorption at 22 MHz as observed at Penticton. Author (TAB)

N67-38852*# Volt Technical Corp., Washington, D. C.
REGISTRATION OF LOW-ENERGY PROTONS ABOARD AES OF THE SERIES "ELEKTRON" [REGISTRATSIYA PROTONOV MALYKH ENERGIY NA SPUTNIKAKH SERII "ELEKTRON"]
E. N. Sosnovets 16 Oct. 1967 7 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. (Moscow), v. 30, no. 11, 1966 p 1820–1823
(Contract NAS5-12487)
(NASA-CR-85368; ST-PF-10657) CSCL 04A

A general pattern of earth trapped proton distribution is constructed on the basis of measurements carried out on four Elektron series satellites. The results obtained were comparable because the sensors installed on the satellites were identical. The characteristic singularities of the proton distributions of various energies are defined. Author

N67-38932* Volt Technical Corp., Washington, D. C.
NEUTRON RADIATION OF THE MOON INDUCED BY COSMIC RAYS [NEYTRONNOYE IZLUCHENIYE LUNY VYZVANNOYE KOSMICHESKIMI LUCHAMI]
V. F. Zakharchenko 5 Oct. 1967 4 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. (Moscow), v. 30, no. 11, 1966 p 1813–1814
(Contract NAS5-12487)
(NASA-CR-89297; ST-LPS-CR-10651) CSCL 20H

This note shows how the results of measurements of the neutron flux near the surface of the moon provide the possibility in principle of deriving conclusions as regards to at least the relative chemical composition of its surface layer. Author

N67-39051*# Maryland Univ., College Park. Dept. of Physics and Astronomy.
THE SIZE OF ANTIMATTER BODIES AND THE PRIMARY COSMIC RAY FLUX
J. R. Wayland Sep. 1967 15 p refs
(Grant NsG-695)
(NASA-CR-89306; TR-737) CSCL 20H

The consequences of antimatter bodies on the very high energy primary cosmic ray flux are considered. The effects of various models of cosmic ray origin and properties of astrophysical parameters are discussed. A simple expression for the production of antiprotons in N–N collisions as a function of energy of the incident proton is obtained by utilizing characteristics of particles produced in high energy collisions. It is assumed that sufficient time will have elapsed for all antibaryons to decay to antiprotons. Author

N67-39075*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.
RAPID NEUTRON CAPTURE IN SUPERNOVA EXPLOSIONS
J. W. Truran, W. D. Arnett, S. Tauruta (Smithsonian Astrophys. Obs.), and A. G. W. Cameron (Yeshiva Univ.) [1967] 34 p refs
(NASA-TM-X-60443) CFSTI: HC$3.00/MF$0.65 CSCL 20H

The implications of recent studies of the dynamics of the cores of highly evolved massive stars are considered with regard to the general problems of nucleosynthesis. The typical conditions estimated for these models are shown to be very promising for the process of element synthesis by neutron capture on a fast time scale (the *r*-process of Burbidge *et al*, 1957). Author

N67-38322*# Volt Technical Corp., Washington, D. C.
MEASUREMENT OF THE INTENSITY OF COSMIC RADIATION DURING THE FLIGHTS OF AUTOMATIC INTERPLANETARY STATIONS ZOND-1, ZOND-2, ZOND-3, LUNA-5, LUNA-6 [IZMERENIYE INTENSIVNOSTI KOSMICHESKOGO PRI POLETAKH AVTOMATICHESKIKH MEZHPLANETRYKH STANTSIY ZOND-1, ZOND-2, ZOND-3, LUNA-5, LUNA-6]
G. P. Lyubimov 11 Oct. 1967 6 p refs Transl. into ENGLISH from Izv. Akad. Nauk SSSR, Ser. Fiz. (Moscow), v. 30, no. 11, 1966
(Contract NAS5-12487)
(NASA-CR-88982; ST-CR-IS-10655) CFSTI: HC $3.00/MF $0.65 CSCL 20H

This paper gives a brief illustration of the results of measurements obtained with the aid of Geiger counters installed on Soviet planetary probes. The variation of cosmic ray intensity and its dependence on solar activity are described. Comparisons are made with the results obtained on spherical probes in the Murmansk region, and with Elektron-2, Elektron-4, Kosmos-17, and Kosmos-53 satellites. Author

30 SPACE SCIENCES

Includes astronomy and astrophysics; cosmology; lunar and planetary flight and exploration; and theoretical analysis of orbit and trajectory. For related information see also: 11 Facilities, Research and Support; and 31 Space Vehicles.

N67-38085*# National Aeronautics and Space Administration, Lewis Research Center, Cleveland, Ohio.
ROUND-TRIP TRAJECTORIES TO MOONS OF JUPITER
Roger W. Luidens and John Edgar Washington, NASA, Oct. 1967 42 p refs
(NASA-TN-D-4167) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The general mission considered has a total trip time of 1000 days with a 100-day stay at Jupiter. The mission begins with a 1.1 circular orbit at Earth and uses atmospheric braking at Earth return. Flybys of the moons of Jupiter and stopovers there are considered. Nonstop lunar flybys made by modifying a Jupiter nonstop flyby yielded the lowest propulsive velocity increments (6.0 to 7.39 mi/sec) but the highest lunar passage velocities (10 to 20 mi/sec). Lunar flybys made from a 25-day Jupiter parking orbit required about twice the propulsion (16.8 mi/sec) but gave lower passage velocities (3.5 to 5 mi/sec). For the lunar stopover mission, the lowest total propulsive velocity increment (15.6 mi/sec) occurred for the following conditions: (1) The moons were visited starting from the outermost and proceeding to the innermost. (2) The arrival at the first moon and the departure from the last moon were by maneuvers that involved three propulsive impulses. (3) Elliptic parking orbits were used at the moons. The stopover mission can also be accomplished from a Jupiter parking orbit but with a slightly higher propulsive requirement. The possibility is discussed of using multiphase interplanetary trajectories and refueling techniques for the interlunar maneuvers to reduce the propulsion requirements. Author

N67-38137# International Business Machines Corp., Cambridge, Mass. Advanced Space Systems Dept.
PROGRAM SOLUTIONS TO SPACE SCIENCE PROBLEMS
Louise Coury and Koo Sun Kim Aug. 1967 57 p refs
(Contract AF 19(628)-6065)
(AFCRL-67-0465; SR-1; AD-657333)

The report describes the analysis and programming required in the development of eight computer programs which cover a wide variety of scientific research. Some of these investigations are inter-related, such as the geomagnetic co-ordinate conversion and magnetic field determinations, while others range from radar-trajectory analysis to electromagnetic theory. For each case, this report describes the mathematical development as well as the programming aspects in order to more completely define the problems and increase their applicability. While the problem descriptions of this document are mathematically oriented, the sections explaining the programming aspects of each problem are designed to facilitate the use of the computer programs by programmer and scientist alike. The specific topics covered in this report are: Orbiting Geophysical Observatory (OGO), Scattering Integration Analysis (SCATT), Electromagnetic Integration Analysis (INTE), Trajectory Analysis for Single Station Radar (TRAJ-1), Proton and Electron Ionosphere Models (ION), Magnetic Field and B and L Determination (FIELD), Geomagnetic Co-ordinate Conversion (GEOMAG), Transcendental Equation Analysis (OPTIC). Author (TAB)

N67-38161*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SURVEYOR III MISSION REPORT. PART II: SCIENTIFIC RESULTS
1 Jun. 1967 222 p refs
(Contract NAS7-100)
(NASA-CR-88952; JPL-TR-32-1177) CFSTI: HC $3.00/MF $0.65 CSCL 22A

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2. TELEVISION OBSERVATIONS FROM SURVEYOR III E. M. Shoemaker, R. M. Batson, H. E. Holt, E. C. Morris, J. J. Rennilson et al p 9–66 refs (See N67-38163 23-30)

3. SOIL MECHANICS SURFACE SAMPLER: LUNAR SURFACE TESTS, RESULTS, AND ANALYSES R. F. Scott and F. I. Roberson p 69–110 ref (See N67-38164 23-30)

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6. LUNAR SURFACE ELECTRICAL PROPERTIES W. E. Brown, Jr., R. A. Dibos, G. B. Gibson, D. O. Muhleman, W. H. Peake et al p 189–194 refs (See N67-38167 23-30)

7. LUNAR THEORY AND PROCESSES D. Gault, R. Collins, T. Gold, J. Green, G. P. Kuiper et al p 195–213 refs (See N67-38168 23-30)

N67-38162*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
PRINCIPAL SCIENTIFIC RESULTS OF THE SURVEYOR III MISSION
L. D. Jaffe, S. A. Batterson, W. E. Brown, Jr., E. M. Christensen, D. E. Gault et al *In its* Surveyor III Mission Rept. Pt. II 1 Jun. 1967 p 3–7 (See N67-38161 23-30)

Mechanical properties of lunar surface materials and microscopic features of the local terrain are among the scientific results reported for the Surveyor III mission. Characteristics of the local microstructure are noted, along with effects of engine exhaust and the nonstatic nature of the lunar surface. The relation of properties at the Surveyor I and Surveyor III landing sites are indicated, and some general astronomical observations are reported. M.W.R.

N67-38163*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
TELEVISION OBSERVATIONS FROM SURVEYOR III
E. M. Shoemaker, R. M. Batson, H. E. Holt, E. C. Morris, J. J. Rennilson et al *In its* Surveyor III Mission Rept. Pt. II, 1 Jun. 1967 p 9–66 refs (See N67-38161 23-30)

Operating characteristics and categories of new information provided by television pictures are reviewed along with a description of the television camera used aboard Surveyor III. Location of Surveyor III on the moon is noted and several photographs and topographic maps are included to indicate the landing site topography and spacecraft attitude. The small craters, patterned ground, and fragmented debris at the landing site are discussed and the lunar surfaces disturbed by Surveyor III are reported. Geological interpretation of these lunar terrain data are presented, including the origin of the observed craters and fragmented debris, the creep of lunar regolith, and the processes leading to diversity of albedo. Photometric and colorimetric observations of lunar surface are reported, as are the eclipse of the sun by the earth and the partially illuminated earth as seen from Surveyor III. M.W.R.

N67-38164*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
SOIL MECHANICS SURFACE SAMPLER: LUNAR SURFACE TESTS, RESULTS, AND ANALYSES
R. F. Scott and F. I. Roberson *In its* Surveyor III Mission Rept. Pt. II, 1 Jun. 1967 p 69–110 ref (See N67-38161 23-30)

Subsystems and functional descriptions are given for the soil mechanics surface sampler that was modified for use aboard Surveyor III. Originally planned strain, acceleration, and position measuring systems were removed in favor of a means of measuring current drawn by the motors. The extension/retraction mechanism, drive system, scoop, and motor control are described; as are engineering performance and lunar surface operations of the sampler. Lunar surface materials tests performed dealt with bearing, trenching, impact, material handling and dumping, and determination of homogeneity of the lunar soil and the depth variation of lunar soil properties. M.W.R.

N67-38165*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LUNAR SURFACE MECHANICAL PROPERTIES
E. M. Christensen, S. A. Batterson, H. E. Benson, R. Choate, L. D. Jaffe et al *In its* Surveyor III Mission Rept. Pt. II, 1 Jun. 1967 p 111–153 refs (See N67-38161 23-30)

Landing impacts, telemetry data from Surveyor III, and a comparison with Surveyor I data form the basis for interpretational analyses of the mechanical properties of the lunar surface. Landing, footpad/surface interactions, vernier engine effects, auxiliary mirrors, and the attitude control jet experiment are discussed. Simulated landing studies and footpad imprint simulations are included, and pictures of the latter are analyzed. Reflective properties of the lunar soil, estimations of soil parameters, elastic properties of lunar soil, camera mirror contamination versus vernier erosion, and a strength estimate of lunar rock are reported. M.W.R.

N67-38166*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LUNAR TEMPERATURES AND THERMAL CHARACTERISTICS
J. W. Lucas, J. E. Conel, R. R. Garipay, W. A. Hagemeyer, C. B. Jones et al *In its* Surveyor III Mission Rept. Pt. II, 1 Jun. 1967 p 155–187 refs (See N67-38161 23-30)

Surveyor III data on lunar surface temperatures, thermophysical characteristics, and spacecraft thermal performance on the lunar surface are reported. Since the spacecraft carried no specific instrumentation to measure lunar surface temperature, outer canister temperatures of the electronic compartments were used to estimate average brightness. Thermophysical properties of the Surveyor III site are discussed as determined by earth-based data. Attention is given to directional effects of lunar infrared emission, the spacecraft view of the lunar surface, and spacecraft raw data. Shading effects on compartments are discussed and both Lambertian and directional lunar surface temperature calculations are included. Tentative conclusions from the lunation data indicate that lunar surface temperatures measured by both Surveyors are in good agreement around noon and compatible with a homogeneous surface model with thermal inertia greater than 400. Differences between compartment temperatures during the morning are explained by different local lunar surface sun phase angles and by directional thermal emission. Based on the correspondence of lunar surface brightness temperatures obtained by Surveyors I and II, it is concluded that there is no thermally significant dust on the compartment faces. M.W.R.

N67-38167*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LUNAR SURFACE ELECTRICAL PROPERTIES
W. E. Brown, Jr., R. A. Dibos, G. B. Gibson, D. O. Muhleman, W. H. Peake et al *In its* Surveyor III Mission Rept. Pt. II, 1 Jun. 1967 p 189–194 refs (See N67-38161 23-30)

Radar altimeter and doppler velocity sensor measurements by Surveyor III indicate radar cross sections for the 25-deg off-normal vertical beams to be approximately the same as those obtained with Surveyor I. The relative dielectric constant for the regions external to the crater where Surveyor III landed is estimated at 3.5±0.7. M.W.R.

N67-38168*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
LUNAR THEORY AND PROCESSES
D. Gault, R. Collins, T. Gold, J. Green, G. P. Kuiper et al *In its* Surveyor III Mission Rept. Pt. II, 1 Jun. 1967 p 195–213 refs (See N67-38161 23-30)

Position of the lunar surface and properties of the lunar surface layer are considered in terms of preliminary data reduced from the Surveyor III mission. Consideration is given to the general morphology of the lunar landing site, evidence for downhill material transport, and the lunar dielectric constant. Preliminary data evaluation give information about the relation between the surface material responsible for the photometric properties and the deeper layers of material in which the properties resemble those of ordinary terrestrial soils. M.W.R.

N67-38197*# Cornell Univ., Ithaca, N. Y. Center for Radiophysics and Space Research.
PHOTOMETRIC AND OTHER LABORATORY STUDIES RELATING TO THE LUNAR SURFACE
Bruce Hapke [1967] 27 p refs Sponsored also by General Motors Corp.
(Grant NsG-382)
(NASA-CR-89078) CFSTI: HC $3.00/MF $0.65 CSCL 03B

The reflecting characteristics of a wide variety of surfaces were investigated in order to determine the properties which are essential for lunar type scattering. Results of the photometric measurements on the intensity of light reflection indicate that in order to backscatter light as strongly as the moon does, its material must have not only an extremely porous and open structure, but the cavities in the surface must also be interconnected. The data indicate that the lunar surface is covered to an unknown depth by a layer of rock dust whose particles have an average size of about 10μ. The grains of rock are probably darkened by exposure to solar radiation and arranged by micrometeorite bombardment into a porous material with a bulk density only one-tenth that of solid rock. L.S.

N67-38198# State Univ. of Iowa, Iowa City. Dept. of Physics and Astronomy.
PROPERTIES OF AN INTERMEDIATE BANDPASS PHOTOMETRIC SYSTEM
John S. Neff and Larry D. Travis Oct. 1966 46 p refs
(Grant NSF GP-4976)
(Rept.-66-42)

Observations of standard stars are presented to define a new intermediate bandpass phogometric system. A comprehensive description of the instrument, reduction procedures and calibration procedures is given, since some of the methods are new. Considerable effort was made to remove or reduce all sources of error in the photometry. A preliminary absolute flux calibration is given, based on scanner observations of Willstrop and Code. A detailed treatment of the second order terms in the absolute calibration and in atmospheric extinction is presented. Author

N67-38240*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
AN ACCURACY AND SPEED COMPARISON OF THE VINTI AND BROUWER ORBIT PREDICTION METHODS
N. L. Bonavito, J. S. Watson, and H. Walden Dec. 1966 18 p refs
(NASA-TM-X-55941; X-543-66-584) CFSTI: HC $3.00/MF $0.65 CSCL 22C

The Vinti orbit prediction method, developed as part of the tracking and prediction program for artificial earth satellites, was compared with the Brouwer orbit prediction method, where both methods considered the first four zonal harmonics of the earth's gravitational field. Several sets of inertial coordinates and velocities for both real and hypothetical satellites were used to produce one hundred revolutions of each orbit. Prediction accuracy was investigated by comparing the in-track position error committed by each of the two methods every ten revolutions. In every case, it was found that the Vinti method produced considerably less in-track error, while operating at a computational speed comparable to that of the Brouwer method. It is seen that when one attempts to augment the Brouwer method so that it can carry accuracy of the order of the Vinti theory, then the computational speeds of the two methods are no longer comparable, but the Vinti program is estimated to be faster by at least a factor of eight. Simultaneously, the computer storage requirements for the Vinti program are estimated to be much less than those of the Brouwer program. Author

N67-38252# Air Force Missile Development Center, Holloman AFB, N. Mex.
SATELLITE POSITION AND VELOCITY PERTURBATIONS DUE TO ERRORS AT INJECTION
Richard J. Schulte Jun. 1967 40 p refs
(MDC-TR-67-78; AD-657028)

The orbit of a near-earth satellite will, in general, be different from the reference orbit designed by the mission planners. The time varying differences or errors in position and velocity can usually be traced to random uncertainties in the booster guidance system. As a result, the in-orbit errors are statistical in nature and their prediction usually requires a complex computer study. The paper reports a simpler approach to the prediction of satellite position and velocity errors in-orbit. A set of analytic equations are developed which express a satellites position and velocity errors as a function of time and initial errors. These equations permit an understanding of the dynamics of vehicle motion. They can be used to cross check more sophisticated computer studies. The approximate solutions permit easy study of satellites at various altitudes and error propegation through multiple orbits. The equations show that in a polar coordinate system a satellite exhibits oscillating vertical and cross plane position errors while the downrange position error grows as a linear function of time. Author (TAB)

N67-38310# California Inst. of Tech., Pasadena. Owens Valley Radio Observatory.
ACCURATE POSITIONS OF SELECTED 4C SOURCES
E. T. Olsen 1967 18 p refs Submitted for publication
(Contract N00014-67-A-0094-0008)
(Rept.-6; AD-653260) CFSTI: HC $3.00/MF $0.65

Positions and flux densities at 1417 MHz of 490 radio sources have been measured using the two 90-ft steerable paraboloids at the Owens Valley Radio Observatory as an east-west and a north-south interferometer. After confusion has been taken into account, most of the positions are accurate to within plus or minus 20 sec. in each coordinate and most flux densities to within plus or minus 0.1 F.U. Author (TAB)

N67-38348*# Volt Technical Corp., Washington, D. C.
A TWO-LAYER MODEL OF VENUS ATMOSPHERE (INTERPRETATIONS OF RADAR OBSERVATIONS) [DVUSKHSLOYNAYA MODEL' ATMOSFERY VENERY (OB INTERPRETATSII RADIOLOKATSIONNYKH NABLYUDENIY)]
Y. N. Vetukhnovskaya and A. D. Kuz'min 10 Oct. 1967 8 p Transl. into ENGLISH from Astron. Vestn. (USSR), v. 1, no. 2 p 85-88
(Contract NAS5-12487)
(NASA-CR-88980; ST-LPS-RA-10654) CFSTI: HC $3.00/MF $0.65 CSCL 03B

A two-layer model atmosphere of Venus is considered. It satisfies the data of both the radioastronomic and radar measurements, including the measurements at 3 cm. It shows a considerable decrease of the effective cross-section of Venus' reflection at short wavelengths. The first upper absorbing layer, being "cold", determines the spectrum of its proper radiation, but is transparent for the radiation with wavelength $\lambda > 3$ cm. This is why it does not affect the results of radar observations. The second absorbing layer, being near the planet's surface, and therefore "hot", absorbs the centimeter radiation and determines the frequency dependence of the effective Venus' reflection but does not influence the brightness temperature of the planet, for the temperature of this layer is similar to that of planet's surface. A surface absorbing layer may be a lower row of clouds, containing $(1 \div 2) \cdot 10^{3}$ g/cm^2 of dust or about 2 g/cm^2 of polar liquid with equipartition time of $(1 \div 2) \cdot 10^{-11}$ sec. Author

N67-38374*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE LOCAL SUPERGALAXY AS THE STRUCTURED ASPECT OF A UNIVERSAL BACKGROUND OF X-RAYS
Elihu Boldt Sep. 1967 5 p refs
(NASA-TM-X-55955; X-611-67-486) CFSTI: HC $3.00/MF $0.65 CSCL 03A

It is shown that Silk's model for a universal X-ray background leads to a measurable structure arising from the local supergalaxy. A telescope tuned for detecting this structure would have a field of view >1 arc degree with a resolution <10 arc minutes. The ratio of the expected signal to the observed diffuse background is of the order of unity. Author

N67-38438# European Space Vehicle Launcher Development Organization, Paris (France).
AN INTRODUCTION TO THE PROBLEM OF LOW THRUST ORBITAL TRANSFER [PRELIMINAIRES AU PROBLEME DES CORRECTIONS ORBITALES A FAIBLE POUSSEE]
E. Cambi Aug. 1967 35 p refs In FRENCH
(ELDO-TM-101) CFSTI: HC $3.00/MF $0.65

A round-up is given of available methods of discussing orbital transfers under low thrust, especially of the 'direct' equations

giving as a function of time the coordinates of the moving point and also the 'planetary' equations yielding the law of variation of the parameters of the osculating orbit. These latter equations can be handled much more easily especially if one takes the time average of the various terms so as to determine the 'secular' variations. However, some examples show that this last procedure can be dangerous and in any case it is preferable to resort to direct equations. Author (ESRO)

N67-38442# European Space Vehicle Launcher Development Organization, Paris (France).

VARIABLE TANGENTIAL ACCELERATION IN ORBITAL TRANSFER [CORRECTIONS ORBITALES A ACCELERATION TANGENTIELLE VARIABLE]

E. Cambi Aug. 1967 9 p refs In FRENCH

(ELDO-TM-MO2) CFSTI: HC $3.00/MF $0.65

In the case of a transfer under tangential thrust, the equations to be used are discussed in the light of various hypotheses concerning the law of variation of the thrust and for that of the resistance. Author (ESRO)

N67-38632# France. Office National d'Etudes et de Recherches Aerospatiales, Chatillon-sous-Bagneux.

APPLICATION OF THE GRADIENT METHOD TO THE NUMERICAL STUDY OF LIMITED-POWER TRANSFERS BETWEEN NEAR-COPLANAR CIRCULAR ORBITS. COMPARISON WITH THE LINEARIZED SOLUTION [APPLICATION DE LA METHODE DU GRADIENT A L'ETUDE NUMERIQUE DES TRANSFERTS A PUISSANCE LIMITEE ENTRE ORBITES CIRCULAIRES COPLANAIRES PROCHES. COMPARAISON AVEC LA SOLUTION LINEARISEE]

Herve Girard 1967 90 p refs In FRENCH; ENGLISH summary

(ONERA-TN-112(1967))

In this analysis we try to find, by means of a numerical method, the optimum trajectories for orbital transfers between coplanar circular orbits having nearly the same radius and for power-limited propulsion systems whose ejection velocity may vary. The results obtained are compared to those given by a linearized analytical calculation. The gradient method, which was retained following an examination of the various applicable methods of optimization, permitted computation of the transfer trajectories with and without rendezvous and also the corresponding consumption. An examination of these results leads to an evaluation of the validity of the hypothesis of linearization around the initial orbit as a function of the radius ratio. Author

N67-38549* Space-General Corp., El Monte, Calif.

FEASIBILITY STUDY FOR A MULTIPLE SATELLITE SYSTEM. VOLUME II: APPENDICES

[1967] 413 p refs

(Contract NAS2-3925)

(NASA-CR-73143; SGC-1089R-3, Vol. II, Append.) CSCL 22A

The appendices to a feasibility study for a multiple satellite system are presented. These 26 appendices deal with the major mission options, scientific implications on spacecraft requirements, a preliminary evaluation of Option 3 separation distances and accuracies, the selection of common orbit parameters, coverage of the subsolar line, booster vehicle considerations, launch window considerations, the reference orbit, deployment sensitivities, deployment velocity and accuracy requirements, aspect sensing, spin axis drift, STADAN interface, communications link and tracking performance analysis, satellite tracking, communications coverage, magnetic tape recorders, multiple satellite magnetic design, reliability criteria and analyses, electromagnetic interference control, environmental criteria, system evaluation for design, balance requirements, thermodynamic design, power profile, and boom shadow considerations and the effect on power system design. R.N.A.

N67-38579*# National Aeronautics and Space Administration, Washington, D. C.

SPACE SCIENCE AND APPLICATIONS PROGRAM Annual Summary Report, 1 Aug. 1965–31 Jul. 1966

Oct. 1967 419 p refs Supersedes NHB-8030.2, Dec. 1965 (NHB-8030.2A; NHB-8030.2) CFSTI: HC $3.00/MF $0.65 CSCL 22A

All approved space flight investigations and experimental and theoretical supporting research which have been active during the period 1 August 1965 through 31 July 1966 are summarized. The investigations and research are reviewed on a disipline basis or in an applications area and include astronomy, solar physics, particles and fields, ionospheres and radio physics, planetary atmospheres, planetology, bioscience, and space applications. Included within each discipline or applications area is a summary statement of objectives, a review of the techniques and instrumentation, and a detailed listing of the flight investigations and supporting research. The detailed listings contain capsule descriptions of the investigations and supporting research, the names of the investigators and their affiliations, and an indication of each discipline or applications area having primary concern or secondary interest in the outcome of the investigation. R.N.A.

N67-38662# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.

A MANIFOLD OF PERIODIC ORBITS

Andre Deprit and Jacques Henrard Jun. 1967 214 p refs *Its* Mathematical Note No. 515

(D1-82-0622; AD-657341)

In the restricted problem of three bodies, when the mass ratio is such that the characteristic exponents at L sub 4 are equal in pair, the triangular equilibrium is a point of ramification in the analytical manifold of periodic orbits emanating from L sub 4; the branch L sub 4 superscript S of short period orbits can be continued through L sub 4 by the branch L sub 4 superscript L of long period orbits, and this real analytical continuation is unique. The branch L sub 4 superscript L ends with an orbit traveled twice which is an element of L sub 4 superscript S. The branch L sub 4 superscript S meets its mirror image L sub 5 superscript S of short period orbits around L sub 5 on a symmetric orbit which is also an element of the branch L sub 3 of periodic solutions emanating from the collinear equilibrium L sub 3. Around L sub 4, the branches L sub 4 superscript L and L sub 4 superscript S are connected by bridges B(PL,QS) of periodic orbits which start from a long period orbit traveled P times and end with a short period one traveled Q times. We have completely explored the bridges B(2L,3S), B(3L,4S) and B(4L,5S). Author (TAB)

N67-38678# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.

DYNAMICAL EQUATIONS FOR THE POSITION AND ATTITUDE OF A SPACECRAFT WITH TIME DEPENDENT MASS AND MASS PROPERTIES

V. L. Pisacane, W. H. Guier, and P. P. Pardoe Jun. 1967 54 p refs

(Contract NOw-62-0604-c)

(TG-919; AD-656891)

Nonlinear differential equations for the position and attitude of a spacecraft under the influence of gravitational and nonconservative forces are developed in terms of Lagrangian mechanics. The significance of the results is that the equations are cast in a form which makes them suitable for digital solution. The spacecraft is assumed to have a completely general configuration with mass a function of time, and mass properties a function of time and the generalized coordinates and velocities. The equations of motion for the center of mass of the system are obtained in terms of a perturbation from an arbitrary reference trajectory. The equations describing the attitude motion are in terms of a general

set of Euler angles. These angles relate the orientation of a reference frame fixed in the spacecraft to a reference frame whose orientation can be specified as an arbitrary function of time in inertial space. The introduction of a general set of Euler angles provides either for the convenient use of a dual set of angles to avoid singularities or for the selection of a natural set of angles for a specific application. Expressions for the partitioned energies and the generalized forces are also presented. The paper is concluded with the application of the equations of motion for the case when the reference trajectory is a Keplerian ellipse. The effect of the J2 zonal harmonic term of the gravitational potential expansion of the principal gravitating mass and the coupling between the trajectory and attitude motion are included. Author (TAB)

N67-38879 National Aeronautical Lab., Bangalore (India).
SYNCHRONOUS EQUATORIAL SATELLITES
N. Rajappa and R. P. Parvathi Feb. 1967 25 p refs
(NAL-TN-2)

The equilibrium positions of a synchronous equatorial satellite are shown to be situated in the directions of the extremum positions of the radius of the equatorial section of the synchronous, and not the Earth's geoid. The motion of a synchronous equatorial satellite is best explained on the basis of a much-more-than-elliptically longitudinally heterogeneous shape of the curve of Earth's equator, and with the inclusion of more harmonics of the Earth's gravitational potential in the analysis. The accuracy and adequacy of the known geopotential constants, called for in the numerical determination of the locations of the equilibrium positions of the satellite, is examined. The stability of the satellite around an equilibrium position, subject to an orbital injection error from the uncertainty in the knowledge of exact location of the equilibrium position, is discussed. The stable geostationary equilibrium position in the East, south of West Coast of India, above the Indian Ocean, is better suited for experiments towards exact determination of the locations of equilibrium positions of the satellite. Author

N67-38796* Florida State Univ., Tallahassee. Radio Astronomy Observatory.
A CATALOG OF RADIO OBSERVATIONS OF JUPITER, 1965–1967
J. Williams, J. D. Merritt, D. P. Morrow, and C. H. Barrow 1967 34 p ref
(Contract NAS5-9835; Grant NsG-224-61)
(NASA-CR-89269) CSCL 03A

Radio observations of Jupiter made at Tallahassee during the 1965–1966 apparition are catalogued, as are observations for 1966–1967. Jupiter was observed about five hours daily around transit from September 18, 1965 through March 26, 1966 at 16 and 18 Mc/s. Additional observations were made at 12.5, 16, 18, 22, and 26 Mc/s between October 17, 1966, and April 15, 1967, with the 12.5, 22, and 26 Mc/s recordings ending on December 23, 1966. For both periods of time, results are also included for Grahamstown, Trondheim, St. Osyth, Valencia, and Ibadan at 18 Mc/s frequency. M.W.R.

N67-38808*# National Aeronautics and Space Administration, Washington, D. C.
ASTRONAUTICS AND AERONAUTICS, 1966
1967 486 p refs
(NASA-SP-4007) GPO: $1.50 CSCL 22A

A chronological review is presented of events, discoveries, and other space and aeronautical related activities that occurred in 1966. Taken from the open literature available to the public, this review of astronautics and aeronautics is indexed by subject matter. Appendixes deal with *Satellites, Space Probes, and Manned Space Flights, 1966* and with a *Chronology of Major NASA Launchings* for the year. M.W.R.

N67-38854*# Space-General Corp., El Monte, Calif.
FEASIBILITY STUDY FOR A MULTIPLE SATELLITE SYSTEM, VOLUME I: SUMMARY Final Report
[1967] 156 p
(Contract NAS2-3825)
(NASA-CR-73141; SGC-1089R-3, Vol. I) CSCL 22A

The feasibility of deploying multiple satellites in a non-coplanar array for the purpose of defining spatial and temporal variations of the solar wind in the transition region and near-interplanetary space was investigated. The analysis and design study found the multiple satellite mission to be technically feasible within the current technology. The scope of work covered (1) the establishment of science/system interactions and requirements; (2) the development of major mission options and their comparison leading to the selection of the preferred option; (3) detailed analysis of orbit and control alternatives, including analysis and selection of the common orbit, satellite deployment and system control considerations; (4) the investigation of communications and data handling alternatives including ground station considerations; (5) the specification of system integration criteria, e.g., magnetics, reliability and environmental criteria; and (6) a feasibility design study for the preferred concept, including specification of subsystem characteristics and preliminary weights. Author

N67-38865*# Space-General Corp., El Monte, Calif.
FEASIBILITY STUDY FOR A MULTIPLE SATELLITE SYSTEM, EXTENSIONS NO. 1 AND NO. 2. VOLUME II: APPENDICES
[1967] 114 p
(Contract NAS2-3925)
(NASA-CR-73144; SG-1089R-6, Vol. II, Append.) CSCL 22A

Appendixes to a feasibility study on a multiple satellite system deal with: (1) spin stability of a single-boom satellite configuration, (2) precession damping during the spin stability analysis, (3) an infrared horizon crossing indicator for aspect sensing, and (4) perigee attitude selection. M.W.R.

N67-38875# Lockheed Missiles and Space Co., Palo Alto, Calif. Research Lab.
NEW FINDINGS CONCERNING THE SEMIANNUAL EFFECT IN SATELLITE ORBITAL DECAY DATA
Albert D. Anderson Oct. 1967 30 p refs
(LMSC-6-77-67-40)

A previously proposed hypothesis which explains quantitatively all features of the semi-annual effect and postulates the existence of an appreciable latitude density variation in the winter hemisphere at satellite altitudes is reexamined with respect to a conclusion that there is a high-latitude winter helium bulge above 600 km. It is shown that this conclusion does not invalidate the proposed hypothesis provided the density at a given altitude decreases from the subsolar point toward the winter pole over a range of latitudes. Objections against the hypothesis based on drag data from two high-inclination satellites are examined. It is concluded that the data from these satellites do not definitely contradict the hypothesis. The simple latitude gradient hypothesis deserves serious consideration since it provides a mechanism for the semi-annual effect. New satellite drag data are used to check the hypothesis by means of a concomitant critical test. It is concluded that these new data substantiate the hypothesis. K.W.

N67-38931* Chrysler Corp., New Orleans, La. Space Div.
AS-206 LAUNCH VEHICLE OPERATIONAL TRAJECTORY RANGE SAFETY ANALYSIS
Jan. 1967 142 p refs
(Contract NAS8-4016)
(NASA-CR-89296; TN-AP-67-157) CSCL 22C

The lateral impact zone containment area from the intended flight direction (72° east of North) is determined, for AS-206, to reach a maximum of approximately ±135 km throughout powered flight. For the overflight of Africa, an extreme lateral crossrange deviation, related to the AS-206 mission, is determined to be ±224 km. Since the continent of Africa and Malagasy Republic are encompassed within the range safety corridor, a study of the impact and casualty probability related to the overflight of these land masses is conducted. Under normal operation S-IB stage impact for the AS-206 mission is predicted to occur at 29.89 degrees north geodetic latitude and 75.26 degrees west longitude. S-IVB guidance cutoff signal is predicted to occur at 580.46±22 seconds following first motion at a downrange distance from the launch site of 1773.42±57 km. Flight azimuth limits to useful mission orbits are 57° east of North for the left and 90° east of North for the right. Author

N67-38951 Joint Publications Research Service, Washington, D. C.

THE OBSERVATION OF DISTANT MAN-MADE SPACE OBJECTS

P. P. Dobronravin 21 Sep. 1967 7 p Transl. into ENGLISH from the publ. "Proceedings of International Astronautical Congress, 15th, 1964, Vol. 11" Warsaw, 1965 p 345–347
(JPRS-42699; TT-67-33326)

The difficulties involved in photographing space objects of relatively low brightness and with rapid movement are reviewed, and a method is outlined for overcoming them with special devices. The photographs were obtained using a 2.6 meter reflector with an electronic-optical converter placed at the direct focal point. The telescope moved in such a way that three exposures were taken on each frame, and the frames overlapped. Thus three images of the moving object were produced on a straight line, and also an image appearing in one frame usually appeared in the next frame also. N.E.N.

N67-38955*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

THEORY OF THE INVESTIGATION OF THE ATMOSPHERE OF BINARY STARS BY USE OF THE ANALOGY BETWEEN GAS DYNAMICS AND SHALLOW WATER FLOW

Ernst W. Adams and Burkhard Schultz-Jander (Deutsche Versuchsanstalt fur Luft- und Raumfahrt, Munich (West Germany)) Sep. 1967 23 p refs
(NASA-TM-X-55939; X-641-67-449) CFSTI: HC $3.00/MF $0.65 CSCL 03B

Approximate solutions of the differential equations of continuum isentropic gas dynamics may be obtained for flows in the equatorial plane of a binary star atmosphere if the analogy between gas dynamics and shallow water flows is employed to define pertinent experiments in a rotating water tank. The magnitudes of the local inclination of the tank's bottom and of the resulting local gravitational force at the corresponding point in the binary star atmosphere are proportional. The analogy requires a constant polytropic coefficient of two. This application of the analogy rests on its extension, as presented here, to rotating systems with external force fields. A theoretical evaluation of the analogy, for the case of the earth's atmosphere under hydrostatic conditions with polytropic coefficient equal to two, yields the correct result for the maximum height of the atmosphere where density reaches zero. Author

N67-39037*# Texas Univ., Austin. Engineering Mechanics Research Lab.

ON THE EQUIVALENCE OF THREE TRAJECTORY OPTIMIZATION SCHEMES

G. J. Lastman Feb. 1967 12 p refs
(Grant NsG-551)
(NASA-CR-89329; EMRL-RM-1020) CFSTI: HC $3.00/MF $0.65 CSCL 22C

A perturbation method and an adjoint-perturbation method for the solution of two-point boundary value problems, which arise in the variational treatment of optimal control problems, are shown to be equivalent to a procedure based on the classical Newton's method for m simultaneous equations in m unknowns. Author

N67-39065 Joint Publications Research Service, Washington, D. C.

MINIMUM TIME FOR AN EARTH–MARS–EARTH FLIGHT WITH AN UNREGULATED LOW-THRUST ENGINE

R. F. Avramchenko, V. M. Bezmenov, V. A. Vinokurov, and V. V. Tokarev 11 Oct. 1967 16 p refs Transl. into ENGLISH from Kosmich., Issled. (Moscow), v. 5, no. 3, 1967 p 339–347
(JPRS-42928; TT-67-33554; UDC-629.191) CFSTI: $3.00

The dynamic part of the variational problem is analyzed for delivery of a maximum payload by a constant-thrust engine in a flight from an earth satellite orbit to the orbit of a Martian satellite with return to earth. Computations of the fattest trajectories for plane flight (without cutting out the engine) are given for fixed values of initial acceleration, thrust and escape velocity (or relative fuel consumption) corresponding to a group of low-thrust engines. This makes it possible to determine the dependence of the minimum time for such a flight on the engine parameters. Author

N67-39074* IIT Research Inst., Chicago, Ill. Technology Center.

COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SURFACES USING NEUTRON CAPTURE GAMMA RAYS, JULY 1, 1967–SEPTEMBER 30, 1967

John W. Mandler and John H. Reed 11 Oct. 1967 28 p
(Contract NASr-65(18))
(NASA-CR-89330; IITRI-A6155-6) CSCL 03B

The practicability of using neutron capture gamma rays as a part of NASA's combined neutron experiment for lunar and planetary surface analysis is under investigation. This requires the determination of (1) the feasibility of performing an elemental analysis on a semi-infinite material by means of the capture gamma-ray technique using a pulsed 14-MeV neutron source, (2) the effect on sensitivity of integration with the other neutron techniques, and (3) the sensitivity of the technique under reasonable field conditions. Earlier results indicated that elemental analysis is feasible using thermal neutron capture gamma rays induced by a pulsed source of 14-MeV neutrons. Work done to alleviate the problem areas is described. The inefficient use of neutrons was eliminated by reducing the neutron output per pulse to approximately the output expected in the neutron generator. Lowering the neutron output and changing amplifiers reduced the spectrum degradation and allowed sampling to begin 10 μsec after the end of the neutron burst. The iron–sand sample was replaced by a homogeneous sample of crushed granite. Author

N67-39076*# National Aeronautics and Space Administration. Goddard Inst. for Space Studies, New York.

THE ABUNDANCE OF IRON IN THE SUN AND THE METEORITES

A. G. W. Cameron (Yeshiva Univ.) [1967] 6 p refs
(NASA-TM-X-60444) CFSTI: HC $3.00/MF $0.65 CSCL 03B

It has long been a puzzle that the solar corona appears to be overabundant in metals relative to the photosphere, and that relative to its neighbors iron is a factor four underabundant in the photosphere relative to meteorites. It is suggested that metals

are concentrated in the corona by radiation pressure acting on lines, and that the solar wind has carried away much of the iron in the outer solar convection zone. Author

N67-39081* Chrysler Corp., New Orleans, La. Space Div.
A S-205 REVISED LAUNCH VEHICLE REFERENCE TRAJECTORY
4 Jan. 1967 76 p refs
(Contract NAS8-4016)
(NASA-CR-89333; TN-AP-67-158) CSCL 22C

The AS-205 revised launch vehicle reference trajectory for the AS-205/208 rendezvous mission is reported. Trajectory data are presented for the Saturn IB launch vehicle phases of flight from guidance reference release to orbit insertion. Comprehensive summaries of the launch vehicle characteristics are also presented. The predicted nominal end conditions of flight at S-IB/S-IVB separation and orbit insertion are summarized. The AS-205 Launch Vehicle nominal weight in orbit capability is predicted to be 87,635 pounds for the orbit insertion conditions assumed herein. This orbit insertion weight is 1,471 pounds in excess of the propellant depletion weight. Author

N67-39095* Chrysler Corp., New Orleans, La. Space Div.
A S-206A LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY DISPERSION ANALYSIS
R. M. Blackstock and G. W. Klug 29 Dec. 1966 71 p refs
(Contract NAS8-4016)
(NASA-CR-89294; TN-AP-66-156) CSCL 22C

A dispersion analysis was conducted to establish realistic deviation limits for the AS-206A launch vehicle operational trajectory. The data presented is intended for establishing trajectory parameter envelopes about the predicted S-IB and S-IVB stage end conditions of flight and confirmation of the flight performance reserve requirement. The error sources considered for the dispersion analysis are those associated with predictions of vehicle characteristics, vehicle systems performances, and flight environment. The nominal vehicle and trajectory, error sources, the analytical procedures used, and the results are discussed. R.N.A.

N67-39119* Chrysler Corp., New Orleans, La. Space Div.
SA-204/LM-1 LAUNCH VEHICLE OPERATIONAL FLIGHT TRAJECTORY
28 Apr. 1967 130 p refs
(Contract NAS8-4016)
(NASA-CR-89332; TN-AP-67-212) CSCL 22C

Trajectory data are tabulated for all phases of the Saturn IB SA-2204/LM-1 Launch Vehicle Operational Flight. A comprehensive summary of the launch vehicle characteristics is also presented. The predicted S-IB and S-IVB stage end conditions are summarized. Flight sequence of events; vehicle weight breakdown; mass and propulsion characteristics; guidance and control; and other data are given. Summaries of the tracking and telemetry coverage are presented in charts; and data details will be published at a later date. L.S.

N67-39121# Bonn Univ. (West Germany). Astronomischen Inst.
DETERMINATION OF THE DENSITY OF INTERSTELLAR GASES USING 21-CM OBSERVATIONS [DIE BESTIMMUNG DER DICHTE DES INTERSTELLAREN GASES AUS 21-CM-BEOBACHTUNGEN]
Kristen Rohlfs 1967 35 p refs In GERMAN; ENGLISH summary
Submitted for publication *Its* No. 73
CFSTI: HC $3.00/MF $0.65

The derivation of the formulas relating the measured intensity of the 21-cm radiation with the density of the hydrogen gas and the kinetic temperature was critically evaluated. A summary is given of optical observations which indicate that the interstellar material has a cloudy structure. These clouds fill approximately 6% of the available space inside the spiral arm; near the sun this figure is 2.8%. The formulas connecting radiation temperature with space density and kinetic temperature are provided. Simplifying conditions for these formulas are discussed, and problems connected with the usually applied harmonic mean temperature are briefly stated. Discussed are the heating mechanism and problems of the kinetic temperature of the interstellar hydrogen cloud. Such continuous processes as radiation heating and ambipolar diffusion are contrasted with cloud heating by mutual collision, and a temperature distribution function for the clouds is derived. A set of formulas is given which links hydrogen density with the measured antenna temperature in the case of a limited angular resolution of the antenna. K.W.

N67-39123 Royal Aircraft Establishment, Farnborough (England).
A CONFIGURATION STUDY FOR AN ELDO-PAS TEST SATELLITE BASED ON COMMUNICATIONS REQUIREMENTS
R. W. Bain, J. G. Walker, R. F. West, and W. G. Hughes [1967] 60 p refs
CFSTI: $3.00

The considerations likely to affect the choice of configuration for the ELDO-PAS experimental communications satellite are discussed. In addition to 3-axis stabilized designs, consideration was given to two spin-stabilized designs. The conclusions recommend the 3-axis stabilized design because of its superiority in communication performance, its greater flexibility, and its vastly superior potential for further development. However, based on development cost and timetable estimates, ELDO has decided that the satellite should have a simple spin-stabilized configuration. R.N.A.

N67-39210*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
STUDIES IN INTERPLANETARY PARTICLES
Fred L. Whipple, Richard B. Southworth, and Carl S. Nilsson 31 May 1967 125 p refs
(Grant NSG-87-60)
(NASA-CR-88988; SAO Special Rept.-239) CFSTI: HC $3.00/MF $0.65 CSCL 03B

CONTENTS:

1. ON MAINTAINING THE METEORITIC COMPLEX F. L. Whipple p 1–46 refs (See N67-39211 23-30)
2. PHASE FUNCTION OF THE ZODIACAL CLOUD R. B. Southworth p 47–74 refs (See N67-39212 23-30)
3. SPACE DENSITY OF RADIO METEORS R. B. Southworth p 75–98 refs (See N67-39213 23-30)
4. ORBITAL DISTRIBUTION OF METEORS OF LIMITING MAGNITUDE +6 OBSERVED FROM THE SOUTHERN HEMISPHERE C. S. Nilsson p 101–122 refs (See N67-39214 22-30)

N67-39211*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
ON MAINTAINING THE METEORITIC COMPLEX
Fred L. Whipple *In its* Studies in Interplanetary Particles 31 May 1967 p 1–46 refs (See N67-39210 23-30)
(Contracts NSR-09-015-033; NAS9-4873; AF 19(628)-3248)

The meteoritic influx on the earth is derived from measurements of penetration of space vehicles, radio and photographic meteors, meteorite falls, Apollo asteroids, lunar craters, and comets. The total flux is some 2×10^{-16} g cm^{-2} sec^{-1}

on the surface of a corresponding nongravitating sphere. Such a cloud is self-destructive by collisions. It requires some 10 times the continuous contribution that the Poynting–Robertson effect alone would demand to maintain the zodiacal light and cloud, i.e., some 10 tons per second for quasi-equilibrium. This observational model is consistent with the etching rates observed on stone and iron meteorites and on photographic meteoroids. Various observational and theoretical facts indicate that the cloud up to masses of about 10^5 g is maintained by live comets. The so-called "half-baked" asteroids, however, may compete with comets in contributing to the brightest fireballs. The stony meteorites may be maintained by collisional spallation from earth-crossing asteroids induced by smaller bodies, the Apollo asteroids being derived from the asteroid belt by the gravitational effect of Mars. The cometary meteoritic complex of smaller particles, carrying most of the mass, has a mean lifetime of some 1.7×10^5 yr. Certain puzzles remain in the orbital properties of the Apollo asteroids and of iron and stone meteorites. Author

N67-39212*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
PHASE FUNCTION OF THE ZODIACAL CLOUD
Richard B. Southworth *In its* Studies in Interplanetary Particles 31 May 1967 p 47–74 refs (See N67-39210 23-30)

Zodiacal-light photometry has been analyzed for the phase function and distribution of the particles. It is assumed that a) there is a unique phase function, b) the space density is the product of a distribution in heliocentric latitude and another in radius vector, and c) all the observed light is scattered by interplanetary particles symmetrically distributed about the sun, except for the enhancement at 65° elongation (possibly this is double scattering by ice in the high atmosphere). Various distributions in radius vector are tried, each yielding a phase function, a latitude distribution, and a predicted zodiacal-light distribution. Good fits to the observations are found with radial density distributions similar to that found from radar meteors; these also yield latitude distributions comparable to the meteor distribution. For scattering angles above 60°, the phase functions resemble a Lambert law, except for an extra peak near 180°, which could be caused by particle roughness. Author

N67-39213*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
SPACE DENSITY OF RADIO METEORS
Richard B. Southworth *In its* Studies in Interplanetary Particles 31 May 1967 p 75–98 refs (See N67-39210 23-30)
(Contracts NSR-09-015-033; NSR-09-015-158; NAS9-4875; AF 19(628)-3248)

The space-density distribution of dust in the solar system is estimated from the orbits of approximately 13,000 radar meteors. Approximate corrections are made for unobservable classes of orbits and for other observational selection effects. Within the limits 0.1 to 10 a. u., the space density decreases monotonically outward from the sun. The distribution in heliocentric latitude has a very broad maximum centered on the ecliptic, and a deep minimum over the ecliptic poles. There is no evidence for any substantial enhancement of density in the asteroid belt. The distribution shows the effects of planetary perturbations and collisional destruction. Author

N67-39214*# Smithsonian Astrophysical Observatory, Cambridge, Mass.
ORBITAL DISTRIBUTION OF METEORS OF LIMITING MAGNITUDE +6 OBSERVED FROM THE SOUTHERN HEMISPHERE
Carl S. Nilsson *In its* Studies in Interplanetary Particles 31 May 1967 p 101–122 refs (See N67-39210 23-30)
(Contract NSR-09-015-033)

A radio survey of orbits of meteors of limiting magnitude +6 was carried out at Adelaide, South Australia, during 1961. Each orbit has been weighted for observational and astronomical selection, and the distributions of 1900 orbits are compared to those of other surveys, particularly to those of a faint photographic survey. The distributions for stream orbits and sporadic orbits are given separately. The two most noteworthy distributions are those with perihelion distance and longitude of perihelion. The latter shows evidence of Jupiter alignment for the sporadic meteor orbits, which, however, still does not differentiate between an asteroidal or cometary source. Author

N67-39239*# National Aeronautics and Space Administration, Manned Spacecraft Center, Houston, Tex.
PERSONNEL MANAGEMENT IN R AND D ORGANIZATION: AN ANALYSIS OF THE PHASEDOWN OF THE GEMINI PROGRAM OFFICE AT THE MANNED SPACECRAFT CENTER
Joan B. Coil (Minn. Univ.) 31 Aug. 1967 75 p refs
(NASA-TM-X-60470; MSC-BM-MR-67-3) CFSTI: HC $3.00/MF $0.65 CSCL 22A

This report analyzes and discusses problems the NASA Manned Spacecraft Center experienced when faced with the completion of both the Mercury and the Gemini Program. The report describes the processes used in phasing down the Mercury and Gemini Program Offices. In the phasedown of the latter office, a questionnaire was prepared and administered to the affected employees. The results of this and other analyses are summarized and a set of conclusions and recommendations drawn from them. Author

N67-39294*# RAND Corp., Santa Monica, Calif.
THE RAND SYNC–SAT CALCULATOR
N. C. Ostrander Sep. 1967 41 p refs
(Contract NASr-21)
(NASA-CR-88343; RM-5228-NASA) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Advancing technology will permit the exploitation of high-gain, narrow antenna beams to greatly increase the capability of communication or broadcast satellites in synchronous orbits. The RAND Sync–Sat Calculator was developed to facilitate the calculation of some of the geometric relations between a synchronous, near-equatorial satellite and one or more earth stations. This Memorandum supplements the instructional information printed on the slide chart, provides some examples of its use, and documents the mathematical background of the slide chart. Author

N67-39319* National Aeronautics and Space Administration, Goddard Inst. for Space Studies, New York.
FRIEDMAN COSMOLOGICAL MODELS WITH BOTH RADIATION AND MATTER
Jeffrey M. Cohen [1967] 4 p refs
(NASA-TM-X-60251) CSCL 03B

A recent analytic solution to Einstein's field equations represented a homogeneous and isotropic universe containing both radiation and dust with the space-like surface being flat. Using arguments based on Mach's principle, Wheeler argues that space is closed. This implies for a Friedman universe that the curvature is positive. Using statistical arguments and observational data, H. Y. Chiu argues that the universe can be described by an open Friedman model with negative curvature. This disagreement cannot be resolved since the energy density of the universe is not known to sufficient accuracy. In view of this, consideration is given to all three Friedman cosmological models. R.N.A.

N67-39341*# National Aeronautics and Space Administration, Washington, D. C.
PRELIMINARY SCIENTIFIC RESULTS FROM SURVEYOR V News Release

29 Sep. 1967 60 p
Available from the Scientific and Technical Information Division CSCL 22A

A NASA news release on the preliminary scientific results obtained from the Surveyor V soft touchdown on the lunar surface on September 10, 1967, is presented. Photographic and chemical (using an alpha backscattering instrument) data are discussed. The data are discussed with respect to the topography, geology, mechanical properties, chemical composition, and magnetic properties of the lunar surface. Implications of the data on lunar theory are discussed. Numerous closeup photographs of the lunar surface taken from the Surveyor V are depicted. L.S.

N67-39348# Bonn Univ. (West Germany). Astronomischen Inst.
THE PERTURBATIONS OF Y AQUILAE [DER VERANDERLICHE Y AQUILAE]
Robert Arnold Breinhorst 1967 65 p refs In GERMAN; ENGLISH summary *Its* No. 75
CFSTI: HC $3.00/MF $0.65

Three-colour photoelectric observations of Y Aquilae were obtained between June 1964 and August 1965 with the 14-inch Cassegrain telescope of the Bonn University Observatory Hoher List. The isophotic wavelengths of the colour system used are found near $\lambda = 2650$ Å, $\lambda = 4550$ Å, and $\lambda = 6000$ Å. The light curve (having a total amplitude of only 0.03 in the UV) resembles that of a W Ursae Majoris star with very shallow primary and secondary minima. The period of 1.30227 days obtained from our measurements is very nearly the same as that deduced from the radial velocity curve by F. Jordan in 1914. Because of the asymmetrical shape of the light curve outside eclipses it was necessary to represent the variations by a series including sine-terms. Yet smaller perturbations are observed around the phases 0.2 and 0.8. After preliminary rectification a first approximation for the orbital inclination ($i = 41°$) and the ratio of radii ($k = 0.35$) of the system was found assuming the geometrical properties of the Roche model. Upper and lower limits for the coefficients representing ellipticity and reflection were derived and the resulting curve of residuals constructed. There is considerable evidence that these remaining perturbations may be caused by a gas stream ejected from the surface of the secondary component through the inner Lagrangian point. Author

31 SPACE VEHICLES

Includes launch vehicles; manned space capsules; clustered and multistage rockets; satellites; sounding rockets and probes; and operating problems. For basic research see: 30 Space Sciences. For related information see also: 28 Propulsion Systems; and 32 Structural Mechanics.

N67-38108# European Space Research Organization, Paris (France).
PROPOSAL FOR A DEVELOPMENT PROGRAM OF EUROPEAN TELECOMMUNICATIONS SATELLITES. VOLUME I: PREFACE CONTENTS Final Report
Jun. 1967 59 p
CFSTI: HC $3.00/MF $0.65

Technical specifications are outlined for a preliminary design and a program study of a European experimental communications satellite in the final report of a study made by the European Space Research Organization (ESRO) at the request of the European Conference on Satellite Communications (CETS). Time schedules and cost estimates are noted for the program, and factors affecting the design of experimental systems for television distribution by satellites are outlined in a table of contents. Flywheel and three-axis active stabilization versions of the satellite are noted. M.W.R.

N67-38185*# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
STABILIZATION SYSTEM ANALYSIS AND PERFORMANCE OF THE GEOS-A GRAVITY-GRADIENT SATELLITE (EXPLORER XXIX)
Vincent L. Pisacane, Peter P. Pardoe, and B. Joy Hook Washington, NASA, Oct. 1967 17 p refs
(NASA Order W-12014)
(NASA-CR-903; TG-901) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The stabilization system analysis and orbital performance of the GEOS-A gravity-gradient satellite, which was launched into orbit on 6 November 1965, is discussed. The analysis is performed with the aid of a rather general digital simulation of the nonlinear differential equations of motion. It includes the effects of gravity-gradient forces, orbital eccentricity, eddy current dampers, residual magnetic dipoles, solar radiation pressure, and thermal distortion of the spacecraft's stabilization boom. The attitude measuring system aboard the spacecraft is described, and processing of the attitude data is discussed. Description of failures in the attitude determination system and discussion of the subsequent effects on the experimental attitude results are included. Experimental attitude results are compared with the results of the digital simulation. General agreement is obtained. Author

N67-38302*# Philco-Ford Corp., Palo Alto, Calif. Space and Re-Entry Systems Div.
MULTIPLE SATELLITE SYSTEMS STUDY Final Report
6 Mar. 1967 446 p refs
(Contract NAS2-3926)
(NASA-CR-73140; SRS-TR-146) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A feasibility study has been performed for a multiple launch of four scientific satellites into highly elliptical earth orbit, to make simultaneous field and particle measurements in the region of the interaction between the solar wind and the magnetosphere. This report covers parametric mission analyses which examine methods of deploying the four satellites into the desired orbital array, the specification of the important resultant system requirements, and the development of a configuration concept which will meet the requirements. The basic conclusions are that the mission is indeed feasible, and that the most promising configuration concept is one in which four satellites are deployed simultaneously, near apogee, with radial velocities obtained from the centrifugal forces of a spinning payload cluster. Author

N67-38316# Sandia Corp., Albuquerque, N. Mex.
THE PITCH-DAMPING CHARACTERISTICS OF THE SANDIA TOMAHAWK ROCKET CONFIGURATION
W. A. Millard and G. W. Stone Jul. 1967 39 p refs
(Contract AT(29-1)-789)
(SC-RR-66-690) CFSTI: HC $3.00/MF $0.65

A free-oscillation dynamic testing apparatus suitable for obtaining large amplitude oscillatory data on a high fineness ratio wind tunnel model is described. The results of a dynamic stability test utilizing this apparatus in the Sandia Laboratory 18-inch Hypersonic Wind Tunnel with a model of the Tomahawk sounding rocket at a Mach number of 7.3 are presented. Correlation with theory is included. Author (NSA)

N67-38324*# National Aeronautics and Space Administration, Washington, D. C.
MARINER V PASSES VENUS
17 Oct. 1967 16 p
(NASA News Release-67-267) Available from the Scientific and Technical Information Division CSCL 22B

The scheduled events and experimental measurements for the Venus flyby part of Mariner V's mission are described. The trajectory approaching, and flying behind and around the planet is mentioned, and the sequence of major events is outlined. The scientific investigations are discussed, and are primarily for obtaining additional information on the atmosphere and its radiation and magnetic environments. The instrumentation is reviewed for measuring atmospheric density, temperature, and wind velocity, along with atomic and elementary particle composition. The Deep Space Network communications coverage is also mentioned, and a chronology of encounter sequence is included. N.E.N.

N67-38346*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
BODY MOTION AND ANGLES OF ATTACK DURING PROJECT FIRE FLIGHT II REENTRY
William I. Scallion and John H. Lewis, Jr. Washington, NASA, Oct. 1967 82 p refs
(NASA-TN-D-4183) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The angle-of-attack time history of the Project Fire reentry package was calculated from rate-gyro and accelerometer measurements telemetered during reentry. The measured rates and accelerations are also presented. The reentry velocity was about 11,327 m/sec at an altitude of 121,920 m and the flight-path angle was −14.74°. The results indicate that the reentry package entered the sensible atmosphere at an angle of attack of about 3°. Subsequent to atmospheric encounter, the angle-of-attack envelope successively increased to levels of about 7.7° and 13° and to a maximum of about 19.5° near the end of the experimental period. These changes in angle of attack were caused by disturbances associated with the changing physical characteristics of the reentry package during reentry. Author

N67-38369*# Boeing Co., Seattle, Wash.
LUNAR ORBITER II: PHOTOGRAPHIC MISSION SUMMARY
Washington, NASA, Oct. 1967 93 p
(Contract NAS1-3800)
(NASA-CR-883; D2-100752-1) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The spacecraft launching, systems performance, and mission data are discussed in detail. The tracking and maneuvers during flight are described. The operational performance of the spacecraft and the worldwide command, control, and data recover systems are presented. The environmental, tracking, and performance data are reviewed, and the photographic data of 13 primary and 17 secondary sites are emphasized. High quality wide angle and oblique photos were obtained, and many photographs are included. Also reported are improvement in orbit determination and prediction accuracy, concurrent recording of orbiter transmissions, techniques for accurately positioning the spacecraft to the oblique photographs, and successful temperature control integrated into the operational sequence. Three micrometeoroid impacts were also recorded, with no noticeable effects on spacecraft performance. N.E.N.

N67-38384*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
THE SYSTEMS SAFETY PROGRAM FOR A TOTAL SPACE LAUNCH VEHICLE GENERAL REQUIREMENTS
Preston T. Farish 23 May 1967 25 p
(NASA-TM-X-53812) CFSTI: HC $3.00/MF $0.65 CSCL 22D

This report sets forth the requirements and elements of a program to assure maximum safety. The principles of the program are to be applied during all phases of space launch vehicle system development, including system definition, design, manufacture handling, storage, transportation, testing, checkout, and operation. An outline of the fault tree analysis technique is included in the report. K.W.

N67-38398# Northeastern Univ., Boston, Mass.
DATA TRANSMISSION AND INSTRUMENTATION SYSTEMS FOR SPACE VEHICLES Final Report, 1 Apr. 1963–31 Mar. 1967
J. Spencer Rochefort, Lawrence J. O'Connor, Raimundas Sukys, and Arthur Glazer 30 Apr. 1967 74 p refs
(Contract AF 19(628)-2433)
(AFCRL-67-0338; AD-657287)

The report summarizes the main work carried out under this contract (April 1, 1963 through March 31, 1967). The contract effort can be grouped under programs concerned with an orbiting vehicle, a re-entry vehicle, field support for certain sounding rockets and balloons, evaluation of commercial telemetry system components, and system studies and developments related to telemetry and weather radar. The orbital vehicle effort is concerned with a telemetry subsystem, a data storage system, aspect instrumentation and determination and a commutator. The discussion of the instrumentation of a Trailblazer II rocket for a re-entry experiment includes treatment of an s-band pulsed system, an x-band PPM telemeter and certain probes. A tabulation is given of commercial airborne telemetry components tested and evaluated since detailed results are published in scientific reports which are available to authorized agencies. The field support rendered in connection with the various programs is tabulated. Specific discussion is given to a PAM/FM system, temperature studies of balloon telemetry systems, and the modification of a weather radar. Author (TAB)

N67-38408*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
A PROCEDURE FOR COMPUTING THE MOTION OF A LUNAR-LANDING VEHICLE DURING THE LANDING IMPACT
William C. Walton, Jr. and Barbara J. Durling Washington, NASA, Oct. 1967 74 p refs
(NASA-TN-D-4216) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A procedure for computing the general motions during impact of a vehicle performing a controlled soft landing on the moon is described. The assumptions involved in idealization of the vehicle and landing surface are stated. The equations of motion of the idealized system are derived. A procedure is set forth for numerical integration of the equations. Detailed and explicit instructions are given for coding a digital computer to carry out the computation of an impact history. The procedure takes into account experience obtained from extensive correlations of computed landing motions with results of tests of a model incorporating many of the mechanical actions of a realistic vehicle. The vehicle is idealized as an arbitrary rigid body with up to four legs arbitrarily attached. A leg is composed of three struts in an inverted tripod arrangement. The struts telescope during impact. Telescoping of a strut is resisted by forces which represent the effects of an aluminum honeycomb shock absorber mounted in the strut and the effects of overall system elasticity and damping. Representation of a very general landing surface is allowed. Author

N67-38439# Nationaal Lucht-en Ruimtevaartlaboratorium, Amsterdam (Netherlands).
A WINDTUNNEL INVESTIGATION OF GROUND-WIND LOADS ON THE ELDO-A SATELLITE LAUNCHING VEHICLE IN PRESENCE OF THE UMBILICAL MASTS

J. W. G. Van Nunen 16 Sep. 1966 137 p refs Supersedes NLR-FF-19
(NLR-F-251; NLR-FF-19) CFSTI: HC $3.00/MF $0.65

Tests have been carried out on a 1:20 scale model of the ELDO-A satellite launching vehicle together with the two umbilical masts to determine the ground-wind loads on the vehicle in presence of these adjacent structures. The test variables considered include the wind azimuth angle and the model damping. For certain wind angles a sharp response was measured. Author (ESRO)

N67-38440# European Space Technology Center, Noordwijk (Netherlands).
ATTITUDE PERTURBATIONS OF A SPIN-STABILIZED SATELLITE ON A HIGHLY ECCENTRIC ORBIT
Marc L. Reward Paris, ESRO, Dec. 1966 120 p refs
(ESRO-TN-14) CFSTI: HC $3.00/MF $0.65

The attitude perturbations of a spin-stabilized satellite describing a highly eccentric orbit (e>0.9) are computed by a method combining integration along the orbit with considerations of the dependance of the torque impulse on what occurs at perigee, and taking into account the true orbital history. Expressions are obtained for the averaged torques due to: the interaction of the residual magnetic moment of the satellite with the magnetic field in the various regions of space, the gravity gradient, the eddy-currents (despin and precession), the aerodynamic drag and the solar radiation pressure. The study is illustrated by a numerical example, in which the influence of various design parameters is critically assessed for an actual satellite, and which shows that the solar radiation torque is predominant. Author

N67-38448# National Research Council of Canada, Ottawa (Ontario). Space Research Facilities Branch.
BLACK BRANT ROCKET AAD-II-106 LAUNCHED AT CHURCHILL RESEARCH RANGE, 18 NOVEMBER 1966
Jul. 1967 44 p /tz Operations Requirement No. 214
(SRFB-005) CFSTI: HC $3.00/MF $0.65

This report deals with the engineering aspects of preparing the payload and the launching of Black Brant rocket AAD-II-106 at the Churchill Research Range on 18 November 1966. The payload contained experiments to measure electron densities and energies, electric fields, ionospheric inhomogeneities, auroral absorption, vertical distribution of hydrogen line emission, proton and electron distribution and energies, X-ray distribution, and micrometeoroid distribution. An optical scanner was also included to correlate measurements with visual aurora. Author

N67-38585*# Aerojet-General Corp., El Monte, Calif.
FEASIBILITY STUDY FOR A MULTIPLE SATELLITE SYSTEM. VOLUME I: SUMMARY Final Report
[1967] 101 p
(Contract NAS2-3925)
(NASA-CR-73142; SGC-1089R-6) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The feasibility of deploying multiple satellites into a noncoplanar array for the purpose of defining spatial and temporal variations of the solar wind and the transition region in near-interplanetary space has been investigated. The scope of work covered: further investigation of key areas in the multiple satellite system concept including attitude control, orientation requirements, and error effects; an optimization of the deployment-separation sequence involving definition and analysis of alternate approaches other than the reference concept defined under the original contract; and an evaluation of the applicability of existing satellite designs to the multiple satellite mission. Author

N67-38813*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
DYNAMIC MODEL INVESTIGATION OF TOUCHDOWN STABILITY OF LUNAR-LANDING VEHICLES
Robert W. Herr and H. Wayne Leonard Washington, NASA, Oct. 1967 23 p refs
(NASA-TN-D-4215) CFSTI: HC $3.00/MF $0.65 CSCL 22B

A 1/8-scale dynamic model of a lunar module (LM) type of spacecraft has been tested to determine the overturning stability boundaries for landings on nonlevel surfaces. The model has four inverted tripod legs with aluminum honeycomb shock absorbers in each leg strut. Experimental stability boundaries have been compared with analytical boundaries derived from three different mathematical idealizations of the model: a rigid, nondeformable model; a rigid model with shock absorbers; and an elastic model with shock absorbers utilizing measured model characteristics as inputs to the analyses. The data are used to illustrate the effects of vehicle shock-absorbing action and overall vehicle elastic properties on landing stability. Effects on vehicle landing stability of variations in vehicle velocity, orientation, and the magnitude and direction of the surface slope are shown both experimentally and analytically. In general, it was found that accurate analytical prediction of the critical approach velocities based on overturning stability requires that the analysis include both the model elasticity and shock-absorber characteristics. Further, it was observed that approach yaw angles which result in three-dimensional post-impact tumbling motions can impose severe limitations on landing-approach velocities. Author

N67-38626# Sandia Corp., Albuquerque, N. Mex.
[SANDIA DESPUN ATTITUDE CONTROL SYSTEM]
L. M. Boesart Jun. 1967 10 p Presented at the Am. Astronautical Soc. Symp., Denver
(Contract AT(29-1)-789)
(SC-DC-67-1819; CONF-670710-1) CFSTI: HC $3.00/MF $0.65

The despun attitude control system which completely removes the stabilizing spin developed during a rocket launch is presented. The stabilizing spin or roll rate is stopped by deploying fly-balls attached to the payload with steel cable wrapped around the payload. The attitude control dry nitrogen thrusters remove any residual roll rate and orient the payload in the desired attitude. NSA

N67-38635* Space Technology Labs., Redondo Beach, Calif.
PRELIMINARY DESIGN CONSIDERATIONS FOR A GYRO-DAMPED GRAVITY GRADIENT SATELLITE
R. G. Nishinaga 28 May 1965 111 p refs
(Contract NAS5-3304)
(NASA-CR-89137; STL-8427-6005-RU000) CSCL 22B

This report presents an investigation of preliminary design considerations for a gravity gradient stabilized satellite which utilizes control moment gyros for damping and control. The study is limited to considering small angle performance of a rigid single body satellite about the desired earth-pointing orientation. Provision is made to include the effect of a spinning wheel which provides a constant angular momentum normal to the orbit plane. The gyroscopic effect of the wheel increases the stiffness of the satellite about the earth-pointing axis. Linearized equations of motion for arbitrary gyro orientations are derived and then reduced for several specific gyro configurations. For generality the equations are normalized. The Routh–Hurwitz criterion is utilized to establish the range of parameter values for which the system is stable. A design study is made to select parameters on the basis of minimizing pointing errors due to disturbance torques. For this preliminary analysis disturbances are assumed to occur at harmonics of orbit rate. Finally, an analysis is developed to evaluate the effects of gyro imperfections. Author

N67-38680*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
ON DYNAMICS OF TWO CABLE-CONNECTED SPACE STATIONS
Frank C. Liu 28 Aug. 1967 42 p refs
(NASA-TM-X-53650) CFSTI: HC $3.00/MF $0.65 CSCL 22A

Presented is an analysis of the dynamic problems of two cable-connected space stations rotating about an axis normal to their orbital plane to provide artificial gravity. The dynamics of cable-connected stations in which the cable tension is zero (non-spinning case) are not treated herein. Differential equations of vibration of the elastic cable and the angular movements of the stations are derived. These motions are coupled through the nonhomogeneous boundary conditions of the cable. This mathematical difficulty is resolved by using the concept of concentrated fictitious masses. The cable equation is solved by using Galerkin's approach for both free and forced oscillations. A general nth order determinantal frequency equation of free vibration of the system is obtained. The responses of the space stations to applied time-varying moments are presented in analytical forms. Author

N67-38699*# National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
A PERFORMANCE STUDY FOR THE APPLICATION OF THE SATURN V TO HIGH ENERGY EARTH ESCAPE MISSIONS
Ronald G. Toelle 31 Jul. 1967 44 p refs
(NASA-TM-X-53639) CFSTI: HC $3.00/MF $0.65 CSCL 22D

The results of a performance survey for the application of the product-improved Saturn V launch vehicles to various escape energies are presented. Two upper stage (S-II/S-IVB) propulsion systems (J-2 and J-2S) were investigated. Exchange ratios of payload with respect to vehicle parameters versus C_3 (twice the energy per unit mass) are presented for a C_3 range of 0 to 125 km^2/sec^2. The effect of booster variations and proposed vehicle improvement for different missions can be mapped into the payload through the judicious use of the exchange ratios. These data are primarily for use as a guide to payload planning for various earth escape and interplanetary missions. The results of this performance survey are presented graphically. Author

N67-38850# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
PERFORMANCE OF THE SUPPORT SYSTEMS ABOARD THE DME-A SATELLITE Technical Memorandum, 29 Nov. 1965–Feb. 1967
S. J. Maranto, III, ed. Apr. 1967 113 p refs
(Contract NOw-62-0604-c)
(TG-907; AD-657156)

The report describes the performance of the support systems aboard the DME-A satellite, i.e., the attitude control, attitude detection, telemetry, command, antenna, and power systems, all of which were developed, fabricated, and tested by the Applied Physics Laboratory of The Johns Hopkins University. The scientific results obtained from the experiments aboard the satellite are not discussed in this document. The Introduction and Spacecraft Design sections of this report are presented to familiarize the reader with the project implementations and the basic design of the DME-A satellite, respectively. The DME-A satellite continues to successfully fulfill its mission objectives and provide useful scientific data, even after exceeding by over four months the one-year useful operating lifetime for which it was designed. Author (TAB)

N67-38879*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.
SURVEYOR SPACECRAFT. VOLUME I: FUNCTIONAL DESCRIPTION
R. P. Garvey 15 Apr. 1966 81 p Revised
(NASA-CR-83650; HAC-70-93401, Vol. I) CSCL 22B

This publication provides a functional description of Surveyor Spacecraft A-21. For purposes of description, the spacecraft system is divided into eight major functions, each of which is further divided into subfunctional areas. This functional division provides ready access to the descriptions of each circuit and mechanism within the spacecraft used to perform a specific function. Three major items are utilized to provide the basic functional description: functional block diagrams, and functional schematic diagrams, and functional theory. Author

N67-39026# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
LUNAR VEHICLES [VEHICULE LUNARE]
D. St. Andreescu 10 Mar. 1967 14 p Transl. into ENGLISH from Stiinta Si Teknica (Bucharest), no. 9, 1963 p 30–32
(FTD-HT-66-132; TT-67-62282; AD-655029)

The next step in lunar exploration will be the orbiting of an automated station around the moon, followed by the landing of a mobile station on the satellite. Some of the technical problems related to this station are mentioned: the possibility of moving around, the efficiency of protective systems, the capability of an earth-located command post to be effective on the moon, etc. Various types of lunar vehicles, yet to be invented, are discussed. One vehicle, looking somewhat like a tank and driven by a turbogenerator fed by hydrogen under pressure, will be able to travel 24 hours at 40 km per hour without stopping. Because of the entirely different conditions prevailing on the moon's surface, the "moonmobile" must be based on entirely different concepts than those of earth vehicles. There are plans for a "moonmobile" in the shape of two parallel worm gears, presumably capable of negotiating any kind of terrain. Another vehicle would be spherical in shape, destined for the exploration of lunar craters, it would have electric motors supplied from a solar energy receiver, and hydroscopes to stabilize and orient the cabin, which would house 3–4 astronauts. Another "moonmobile" would "walk" on four articulated extensions; it would have a television camera and a mechanical dust collector, all powered by solar batteries. Finally, another vehicle, the lunar "buggy", would house two astronauts, one at each end of the buggy, and would have a range of 1,200 kilometers. TAB

N67-39056*# National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
THE DECLINE AND FALL OF IMP 3 Preliminary Report
Barbara E. Lowrey Sep. 1967 19 p refs
(NASA-TM-X-55933; X-643-67-494) CFSTI: HC $3.00/MF $0.65 CSCL 22B

Data from the IMP 3 satellite is used to establish an orbit which can be extrapolated until re-entry. The re-entry time is predicted to be the midnight between July 4 and 5, within 1/2 an hour. It is concluded that it is feasible to prepare experiments to observe the satellite re-entry in advance. Further work is in progress to establish a definitive orbit and to increase the accuracy of the decay trajectory. Author

N67-39063*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.
AN APPROXIMATION SOLUTION OF THE EQUATIONS OF MOTION FOR ARBITRARY ROTATING SPACECRAFT
Peter R. Kurzhals (Ph.D. Thesis) Washington, NASA, Oct. 1967 155 p refs
(NASA-TR-R-269) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The assumption of small changes in the inertia parameters has been used to derive approximate rotational equations of motion for arbitrary spinning spacecraft in the small angle and rate regime.

Complex representations are introduced to define the rate and attitude errors produced by applied disturbances, and analytic solutions are obtained for the steady spinning mode and for the spin-up and despin mode. Solutions for the steady spinning mode consider both the uncontrolled and the controlled spacecraft motion for characteristic disturbances. These disturbances include initial errors, externally applied torques, and instantaneous and periodic mass motions within the spacecraft. The errors induced by the disturbances are described by the error component time histories and by vector traces of the complex error representations. Upper bounds of the errors are developed for the uncontrolled motion, and the required control techniques and control systems are examined for the controlled motion. Solutions for the spin-up and despin mode consider extensible spacecraft modules connected by struts or cables. Fuel consumption relations are derived for several extension techniques, and optimization of the extension techniques is shown to yield appreciable fuel savings. Comparisons of the analytical solutions and exact solutions obtained by numerical integration of the complete equations of motion are found to yield excellent agreement, and the applications of the approximate solution are illustrated for a manned orbital research laboratory and a large spinning space station. Author

N67-39066*# National Aeronautics and Space Administration. Manned Spacecraft Center, Langley Station, Va.

TECHNICAL HISTORY OF THE ENVIRONMENTAL CONTROL SYSTEM FOR PROJECT MERCURY

Frank H. Samonski, Jr. Washington, NASA, Oct. 1967 119 p refs

(NASA-TN-D-4126) CFSTI: HC $3.00/MF $0.65 CSCL 06K

This report presents a technical history of the environmental control system for Project Mercury. Significant system changes and flight experience with the environmental control system are described. Attention is also given to the structure of test programs employed to satisfy the mission objectives. Author

N67-39223*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.

ATLAS/AGENA-18 LUNAR ORBITER B OPERATIONS SUMMARY

24 Oct. 1966 31 p

(NASA-TM-X-59256; TR-465) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The launch vehicle and the spacecraft are briefly described, and mission objectives, mission plan, and post injection operations are outlined. The launch operations plan describes the operational areas, the telemetry, optical, and radar data acquisition, the meteorological plan, and lists the key operational personnel. Lunar Orbiter communications facilities for support of the mission are given, and Atlas/Agena and spacecraft operations to be performed during the launch countdown are presented in a table. K.W.

N67-39227*# Avco-Everett Research Lab., Everett, Mass.

THE PLASMA RADIATION SHIELD: CONCEPT, AND APPLICATIONS TO SPACE VEHICLES

Richard H. Levy and Francis W. French 9 Oct. 1967 96 p refs

(Contract NAS8-20310)

(NASA-CR-61176) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The plasma radiation shield is an active device using free electrons, electric and magnetic fields for the purpose of shielding astronauts from energetic solar flare-produced protons. The concept of plasma radiation shielding is reviewed in the light of current studies. The available evidence indicates that the concept is physically sound, but important practical questions remain in at least two areas: these have to do with establishment and control of the extremely high voltages required, and with integration of the concept into a realistic space vehicle design. Author

N67-39240*# Hughes Aircraft Co., El Segundo, Calif. Space Systems Div.

SURVEYOR SPACECRAFT A-21A MODEL DESCRIPTION

1 Sep. 1964 223 p Prepared for JPL

(Contracts NAS7-100; JPL-950056)

(NASA-CR-84186; Rept.-224848) CFSTI: HC $3.00/MF $0.65 CSCL 22B

The general design and overall performance of the A-21A model of the Surveyor spacecraft are described. Surveyor's mission objectives, launch vehicle, and mission sequence of events are discussed along with a brief descriptive summary of the spacecraft's general arrangement, basic design concepts and payload integration. Surveyor's structural and vehicular subsystem, engineering instrumentation, propulsion subsystem, electrical power subsystem, telecommunications subsystem, flight control subsystem, approach television subsystem, scientific payload, mass properties, thermal control, operational sequence, and functional performance are described in detail. R.N.A.

N67-39247*# National Aeronautics and Space Administration. Langley Research Center, Langley Station, Va.

STATIC LONGITUDINAL AERODYNAMIC CHARACTERISTICS OF A HAMMERHEAD-SHAPED LITTLE JOE II—LUNAR MODULE MODEL AT MACH 0.30 TO 1.20

Arvo A. Luoma and Charles D. Harris Washington, NASA, Oct. 1967 155 p refs

(NASA-TN-D-4139) CFSTI: HC $3.00/MF $0.65 CSCL 22B

An investigation of the static longitudinal aerodynamic characteristics of a 0.03-scale model of a proposed Little Joe II—lunar module suborbital space vehicle was made in the Langley 8-foot transonic pressure tunnel at Mach numbers from 0.30 to 1.20 and at angles of attack from approximately -12° to 12°. This configuration was of the hammerhead type, in that the diameter of the lunar module shroud was larger than the diameter of the Little Joe II launch vehicle. Three sizes of stabilizing fins, three nose shapes on the lunar module aerodynamic shroud, and two shroud skirts, which extended over the converging juncture between the shroud and the launch vehicle, were investigated. Flap-type trailing-edge controls on the stabilizing fins were uniformly deflected for pitch control. Control hinge moments were measured on the small fins. Limited transition-strip studies were made on one of the configurations. Author

N67-39258*# National Aeronautics and Space Administration, Washington, D. C.

FOURTH ORBITING SOLAR OBSERVATORY SCHEDULED

11 Oct. 1967 26 p

(NASA News Release-67-262) Available from the Scientific and Technical Information Div. CSCL 22B

This NASA news release was issued on the occasion of the launching of the Orbiting Solar Observatory (OSO-D) on October 18, 1967, to be called OSO-IV in orbit. Objectives of the spacecraft and OSO program management are briefly described. Summarized accounts are given of OSO accomplishments and OSO-D pointed and wheel experiments. OSO-D fact sheets on the spacecraft, the launch phase, and the power subsystem are presented, and statistics are included of the Delta launch vehicle and spacecraft seperation. Also listed are the nominal flight events, the tracking, data acquisition and command stations, and the OSO team. K.W.

N67-39273# Schjeldahl (G. T.) Co., Northfield, Minn.
PAGEOS FABRICATION ACCURACY AND RELIABILITY
S. J. Stenlund and B. D. McLellan *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 133–142 (SEE N67-39261 23-02)

The design of the 100-ft-diam PAGEOS satellite and the reliability program used to predict its reliability are discussed. This was the first use of a space satellite reliability program in balloon design and fabrication. The technique for reliability prediction for PAGEOS inflatable sphere assemblies utilizes known theory of probability in evaluating representative random samples of component characteristics. The end result is component, operational phase, and ultimately system reliability prediction including estimation of failure rates. The use of this program in design and building of load-carrying balloons is discussed. Author

N67-39311* National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
SURVEYOR A (AC-10) FLASH FLIGHT REPORT
31 May 1966 12 p
(NASA-TM-X-57862; TR-368) CSCL 22B

The Surveyor A vehicle was launched from Complex 36 pad A on a flight azimuth of 102.28 degrees at 0941 EST, 30 May 1966. Vehicle performance was nominal, with all events occurring at the planned time. The Atlas sustainer stage was operated until propellent depletion. The Centaur stage was programmed for a single burn operation to provide the necessary velocity to inject the spacecraft into a lunar transfer orbit. Injection was satisfactorily accomplished, the spacecraft was separated from the launch vehicle, and the launch vehicle then performed its retromaneuver to increase the separation distance between the vehicle and spacecraft. Author

N67-39339*# National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
LUNAR ORBITER A FLASH FLIGHT REPORT
15 Aug. 1966 18 p
(NASA-TM-X-57865; TR-422) CFSTI: HC $3.00/MF $0.65 CSCL 22A

The successful launching of Atlas Agena 17 with the Lunar Orbiter A spacecraft from Kennedy Space Center on August 10, 1966 is reported. The report summarizes mission objectives, vehicle and spacecraft configurations, launch vehicle and spacecraft flight performance, range safety and trajectory, and the sequence of flight events. Also presented are data on range telemetry and radar, optics, weather and pad damage, and prelaunch operations. K.W.

N67-39367* Hughes Aircraft Co., El Segundo, Calif.
SURVEYOR SPACECRAFT A-21 MODEL DESCRIPTION
1 Mar. 1965 194 p Prepared for JPL
(Contracts NAS7-100; JPL-950056)
(NASA-CR-84185; Rept.-22487B) CSCL 22B

This document describes the general design and performance of the A-21 model of Surveyor spacecraft in its present state of development. Spacecraft performance is defined only in terms of design and mechanization. Author

32 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; thermal stress; impact phenomena; vibration; flutter; inflatable structures; and structural tests. For related information see also: 17 Materials, Metallic; and 18 Materials, Nonmetallic.

N67-38077# Northwestern Univ., Evanston, Ill. Structural Mechanics Lab.
DISPERSION OF FREE HARMONIC WAVES IN FIBER-REINFORCED COMPOSITES
Jan D. Achenbach and George Herrmann Jun. 1967 26 p refs
(Contract Nonr-1228(34))
(TR-67-3; AD-657461)

A set of displacement equations of motion is proposed that is suitable for the dynamic analysis of fiber-reinforced composites. In deriving the equations, representative elastic moduli are used for the binder, and the elastic and geometric properties of the fibers are combined into effective stiffnesses. With the aid of certain assumptions regarding the deformation of the fibers, and by employing a smoothing operation, approximate kinetic and strain energy densities for the fiber-reinforced composite are obtained. Application of Hamiltons principle yields the displacement equations of motion. The proposed set of equations is employed to study the propagation of plane harmonic waves propagating in the direction of the fibers and normal to the fiber direction. Plane transverse waves propagating in the direction of the fibers are dispersive, and dispersion curves are shown. By proper choice of the representative elastic moduli of the binder, the phase velocity at infinite wave length for transverse waves propagating in the direction of the fibers, and the constant phase velocities for longitudinal waves and waves propagating in the other directions, agree with the values predicted by the effective modulus theory. Author (TAB)

N67-38079# Northwestern Univ., Evanston, Ill. Structural Mechanics Lab.
EFFECTIVE STIFFNESS THEORY FOR LAMINATED MEDIA
Chin-teh Sun, Jan D. Achenbach, and George Herrmann Jul. 1967 37 p refs
(Contract Nonr-1228(34))
(TR-67-4; AD-657462)

In this report a method is proposed to derive displacement equations of motion for a laminated medium. In deriving the equations the displacements of the reinforcing layers and the matrix layers are expressed as linear expansions about the midplanes of the layers. Dynamic interaction of the layers is included through continuity relations at the interfaces. The strain and kinetic energy densities of the layers are computed, where correction coefficients are introduced to compensate for errors in the strains. By means of a smoothing operation, approximate kinetic and strain energy densities for the laminated medium are obtained, and subsequent application of Hamiltons principle yields the displacement equations of motion. For the case of plane strain the equations are worked out in detail. The features of the new theory are exhibited by studying the propagation of plane free harmonic waves in an unbounded medium. Dispersion curves are shown for transverse and longitudinal motions and comparisons are made with curves obtained by using the equations of the theory of elasticity for all layers. The restrictions of the present theory are discussed, and some attention is devoted to a method of improving the results by including quadratic tarms in the displacement expansions. Author (TAB)

N67-38083# Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.
A PRACTICAL SOLUTION TO THE PROBLEM OF THERMAL BENDING IN SPACECRAFT EXTENDIBLE BOOMS
D. W. Rabenhorst Jun. 1967 65 p
(Contract NOw-62-0604-c)
(TG-915; AD-657154)

The report considers solutions for the problem of protecting spacecraft extendible booms from thermal bending in sunlight. It was theorized that such protection could be achieved by devising a sunshield that would fit around the boom like a shroud, and that thermal bending would thus be reduced by orders of magnitude.

However, no designs that would provide the desired protection and at the same time maintain compatibility between the boom and the boom-erection equipment were forthcoming and work on the sunshield was abandoned. This report describes a series of sunshield configurations that satisfy the compatibility requirements and have the following characteristics: Stowed Volume - < 2 cu in/100 ft; Weight - Less than 2 oz/100 ft; Projected Area Deployed - 2-3 times that of the bare boom; Deployment - Automatic - no extra equipment required; Retraction and Redeployment - Automatic - no extra equipment required; Thermal Improvement Over Bare Boom - Greater than 1000%. TAB

N67-38120# California Univ., San Diego. Dept. of the Aerospace and Mechanical Engineering Sciences.
BOUNDS ON STRESSES CAUSED IN SANDWICH ARCHES BY BOUNDED ANELASTIC STRAINS
Jenn-Ming Chern and S. Nemat-Nasser Aug. 1967 25 p refs
(Contract N00014-67-A-0109-0003)
(TR-12; AD-657377)

Bounds are obtained on the bending moments and the resultant thrusts and shear forces that can be induced in a section of a sandwich arch by anelastic strains of unknown distributions but bounded magnitudes. The example of a parabolic sandwich arch is worked out in detail to illustrate the results. Author (TAB)

N67-38123# National Bureau of Standards, Washington, D. C.
STRESS RELAXATION IN AERONAUTICAL FASTENERS Final Report
Nixon Halsey, John H. Gieske, and Leonard Mordfin Feb. 1967 29 p refs
(NBS-9485; AD-657338)

Creep and stress relaxation tests at 1200F were carried out on A-286 alloy material specimens and bolt-and-nut combinations. Details of the testing equipment and procedures are described and several recommendations, in these areas, are made for use in the establishment of a standard stress relaxation test method. Some of the experimental stress relaxation data are compared with calculated values which were developed from the experimental creep data by the application of the strain hardening and time hardening principles. The usefulness of this technique is discussed. Author (TAB)

N67-38149# Hydronautics, Inc., Laurel, Md.
THE DESIGN OF TANKS FOR USE IN AN ACTIVE TANK SYSTEM
William C. Webster Jul. 1967 74 p refs
(Contract NObs-90164)
(TR-490-3; AD-655866)

Detailed consideration is given to the design of the tanks for activated anti-roll tank installations. The tanks considered are of the U-tube type. Methods are presented for selecting the geometry of the tank to obtain the proper tank size frequency. The computation of the damping is made from standard, empirical relations used in hydraulics. In addition, the formulae for computing sloshing are also presented. Author (TAB)

N67-38151# Brown Univ., Providence, R. I. Div. of Engineering.
INFLUENCE OF STRAIN-HARDENING AND STRAIN-RATE SENSITIVITY ON THE PERMANENT DEFORMATION OF IMPULSIVELY LOADED RIGID-PLASTIC BEAMS
Norman Jones Jul. 1967 47 p refs
(Contract ARPA SD-86)
(ARPA-E46; AD-657129)

A simple method is presented for estimating the combined influence of strain-hardening and strain-rate sensitivity on the permanent deformation of rigid-plastic structures loaded dynamically. A study is made of the particular case of a beam supported at the ends by immovable frictionless pins and loaded with a uniform impulse. The results of this work indicates that considering strain-hardening alone when appropriate or strain-rate sensitivity alone gives permanent deformations which are similar to those predicted by an analysis retaining both effects simultaneously. Author (TAB)

N67-38193# California Univ., La Jolla. Dept. of the Aerospace and Mechanical Engineering Sciences.
THE GENERATION OF THERMOELASTIC STRESS WAVES BY IMPULSIVE ELECTROMAGNETIC RADIATION
L. W. Morland Jul. 1967 31 p refs
(Contract N00014-67-A-0109-0003)
(TR-11; AD-657181)

The absorption of electromagnetic radiation within a thin, but finite, surface layer of an elastic half-space provides a sudden heat source distribution through the layer, and stress waves are generated. A solution for uni-axial motion is given in the limit situation when the pulse duration approaches zero in comparison with the wave travel time through the layer, together with the neglect of thermal diffusion on this time scale. The radiation absorption is assumed to decay exponentially with depth. These simplifying features lead to stress wave profiles which clearly illustrate the effective nature of the solution. In the case when the surface is stress free, after the initial build-up (here instantaneous) of compressive stress within the layer, a tensile wave propagates out of the layer. Numerical data are presented to show that the peak tensile stress can attain significant levels within a few layer thicknesses of the surface. Author (TAB)

N67-38243# Brown Univ., Providence, R. I. Div. of Engineering.
THE EFFECT OF AN ELASTIC MEMBRANE ON THE STABILITY OF A TRIAXIAL TEST OF A TIME INDEPENDENT SOIL
Jay B. Weidler and Paul R. Paslay Jul. 1967 17 p refs
(Contract ARPA SD-86)
(ARPA-E47; AD-657344)

Using an analytical model to represent the soil and an elastic-membrane theory to represent the sheath commonly used around the soil sample the stability of the soil-membrane system is studied. The measure of stability used is the time derivative of the rate of doing work by the external loading for a prescribed motion. The results give a means of evaluating the relative effect of the membrane on the initial stability of the system. A numerical example shows the effect to be negligible in the case of the initial stability of a particular soil. Author (TAB)

N67-38284*# Boeing Scientific Research Labs., Seattle, Wash. Mathematics Research Lab.
THE PRECESSION AND NUTATION OF DEFORMABLE BODIES. II: THE FORM OF DISTORTED CONFIGURATIONS
Zdenek Kopal Apr. 1967 50 p refs *Its* Mathematical Note No. 509
(Contract NASw-1470)
(NASA-CR-89005; D1-82-0611; AD-657400) CFSTI: HC $3.00/MF $0.65 CSCL 20K

In the preceding report of this series the Eulerian equations for the precession and nutation of self-gravitating deformable bodies have been set up, with coefficients expressible in terms of the displacement components arising from deformation which may oscillate with the time. The aim of the present report will be to derive an explicit form of the equations which govern the deformations of self-gravitating viscous bodies in an external field of force; and to solve them in the particular case of a homogeneous compressible configuration of arbitrarily high viscosity. A possession of such a solution then opens the way for the evaluation of the coefficients of the generalized equations for the precession and nutation of deformable bodies, and to their eventual solution. TAB

N67-38265# Naval Ordnance Test Station, China Lake, Calif.
ONE-SIDED INVERSES AND ONE-SIDED IDENTITIES IN RINGS
W. O. Alltop Jun. 1967 18 p refs
(NOTS-TP-4322; AD-656895)

Properties of rings with one-sided inverses or one-sided identities are investigated. A characterization of rings with one-sided identities is given. Some structure theory regarding rings with one-sided inverses is developed. Author (TAB)

N67-38355# Texas A&M Univ., College Station.
GOVERNING DIFFERENTIAL EQUATIONS OF PROJECTILE PENETRATION
L. J. Thompson (Sandia Corp., Albuquerque, N. Mex.) Dec. 1966 41 p refs Presented at the 3d Pan-Am. Conf. on Soil Mechanics and Found. Eng., Caracas
(Contract AT(29-1)-789)
(SC-DC-66-2423; CONF-670701-3) CFSTI: HC $3.00/MF $0.65

An overall study of the process of projectile penetration into soil is presented. The governing differential equations for the soil target medium are developed using the equations of motion and the continuity condition. Constitutive relationships are derived from Mohr—Coulomb theory for a rigid plastic material and from viscosity theory. The other necessary equations are generated from experimental investigations of the penetration mechanism. Author (NSA)

N67-38359# Texas A&M Univ., College Station.
EMPIRICAL RELATIONSHIPS FOR OGIVAL PROJECTILE PENETRATION
Fred J. Benson (Sandia Corp., Albuquerque, N. Mex), and B. Rohani Dec. 1966 23 p refs Presented at the 3d Pan-AM. Conf. on Soil Mech. and Found. Eng., Caracas
(Contract AT(29-1)-789)
(SC-DC-66-2424; CONF-670701-1) CFSTI: HC $3.00/MF $0.65

The results of analysis of the time-acceleration traces for cylindrical ogival nose projectiles penetrating a soil medium are presented. The projectiles impact the soil medium at angles approximating 90 degrees. Relationships between acceleration, velocity, and penetration are discussed, and an approximate method of computing the maximum depth of penetration is presented. Author (NSA)

N67-38365# David Taylor Model Basin, Portsmouth, Va. Structural Mechanics Lab.
SHOCK DAMAGE MECHANISM OF A SIMPLE STRUCTURE
L. T. Butt, R. D. Short, Jr., and E. A. Thornton Mar. 1967 61 p refs
(DTMB-2191; AD-657298)

Two sets of four cantilever beams loaded with tip masses were mounted on a floating shock platform and shock tested by underwater explosions. These simple mechanical models were designed to undergo appreciable plastic deformations. Three analytical approaches to predict shock damage were applied to these beam - mass models: one considering elastic - perfectly plastic mode response; another considering an energy balance to predict displacement bounds; and the third considering an inelastic deformation mode approximation. The displacement bound and mode approximation methods were applied considering both elastic - perfectly plastic and rigid - perfectly plastic deformations. The analytical results were compared with experimental data. The elastic - perfectly plastic analysis shows good agreement with experiment up to the initial peak displacement. Computed elastic - plastic bounds and inelastic mode approximations also provide good estimations of the initial displacements. Author (TAB)

N67-38378*# Martin Co., Baltimore, Md.
VIBRATION STUDY OF A PRESSURIZED TORUS SHELL PART I: EXPERIMENTAL STUDY
Peter F. Jordan Washington, NASA, Oct. 1967 62 p refs
(Contract NAS1-6088)
(NASA-CR-884) CFSTI: HC $3.00/MF $0.65 CSCL 20K

Results of a vibration test program performed on a 54-inch (1.4 m) diameter complete circular torus shell are reported. The fundamental frequency response of both the free and the rigidly held model agreed well with analytical predictions. Correlation of the higher frequency modal responses by means of results of cylindrical shell analysis was successful in general, though pneumatic resonances of the air inside the model also played a considerable role. Significant was the occurrence of nonclassical modes, of a high degree of symmetry and evidently not due to model imperfections. Author

N67-38383# New Mexico Univ., Albuquerque. Bureau of Engineering Research.
GENERAL SHELL EQUATIONS UNDER LARGE STRAINS AND ROTATIONS
R. D. Krieg and H. L. Schreyer Jun. 1967 140 p refs Prepared for Sandia Corp.
(Contract AT(29-1)-789)
(SC-CR-67-2641) CFSTI: HC $3.00/MF $0.65

Equations were derived for dynamic shells which are applicable to shells of inelastic materials which undergo large rotations and experience large strains. The Piola–Kirchhoff stress tensor of the second kind (Trefftz stress) together with the Lagrangian strain was used. Direct notation is used except for some work in curved rods. A surface deformation gradient similar to three dimensional gradients of elasticity is used to express the strain field, the equations of motion, and relate generalized stresses and strains in terms of material and spatial quantities. NSA

N67-38385# Southampton Univ. (England). Inst. of Sound and Vibration Research.
ON THE USE OF RECTANGULAR FINITE ELEMENTS
V. Mason Feb. 1967 61 p refs Sponsored by NAS–NRC
(ISVR-161)

The vibration of flat rectangular plates with clamped and simply supported boundary conditions has been investigated using rectangular finite elements. Three element displacement functions were examined to determine the effect of increasing the degree of continuity between adjacent elements. The first function gave continuity of displacement and slope, the second also had continuity of twist, and the third had continuity of displacement, slope, twist and curvature. The second of these was found to be the most satisfactory. This report gives a detailed account of the theoretical background required for an understanding of the Fortran programs written for the above analysis, although a detailed Fortran listing has not been included. Mention is also made of the use of rectangular finite elements for acoustic vibration problems. The investigation was not as thorough as the plate investigation because of the larger amounts of computer storage required. Author

N67-38417# Applied Technology Associates, Inc., Ramsey, N. J.
EFFECTIVE ELASTIC COEFFICIENTS FOR A SPHERICAL SHELL PERFORATED BY MANY RADIAL HOLES
Robert Rung, V. L. Salerno and J. B. Mahoney May 19[illegible]
56 p refs Prepared for Union Carbide Corp.
(Contract W-7405-ENG-26)
(Rept.-112-A; TID-23886) CFSTI: HC $3.00/MF $0.65

Explicit formulas are developed for the calculation of the eight effective stiffnesses of a spherical shell perforated by many radial holes in regular triangular or radially orthogonal patterns

The governing partial differential equations for the unsymmetrically loaded spherical shell are given. Recommendations for refinement of the analysis of the bending case are made. Author (NSA)

N67-38491*# National Aeronautics and Space Administration, Washington, D. C.
STRUCTURAL DESIGN CONCEPTS
L. Albert Scipio (Pittsburg Univ.) 1967 180 p refs
(NASA-SP-5039) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The NASA contributions to the field of structural design are identified, the developments of construction materials associated with the designs are described, and applications are suggested. The basic characteristics of stiffened skin and composite materials for thin walled shell structures are reviewed. The variety of structural materials available, and the selection of the best type for a particular job are discussed. Recent development in structural concepts, their uses, and general types of construction are reported. Details are also given on design synthesis and optimization. The structural types discussed include laminates, filament overwrapped, segmentation, isotensoid, tension shell and tension string, expandable, and sandwich structures. An extensive bibliography is appended. N.E.N.

N67-38496 Laboratorio de Acustica e Sonic, Sao Paulo (Brazil).
ULTRASONIC INSPECTION OF STEEL PLATES ACCORDING TO ASTM A-435/57T AND VDE-ENTWURF-072/57 AND OF ARBITRARY PARTS [INSPECAO ULTRASONICA DE CHAPAS DE ACO DE CONFORMIDADE COM ASTM A-435/57T E VDE-072/57—ENTWURF E DE PECAS AVULSAS]
L. X. Nepomuceno, W. Visentini, and M. F. Barbosa 20 Feb. 1967 38 p refs In PORTUGUESE
(Rept.-6702.283)

The report describes equipment and accessories, procedures, and results of an ultrasonic inspection of a set of roughly 450 m^2 steel plates and a lot of arbitrary steel bodies. The results are presented in table and schematic form. Photographs are also included. Author

N67-38534*# Michigan Univ., Ann Arbor.
FORE-AND-AFT STIFFNESS CHARACTERISTICS OF PNEUMATIC TIRES
R. N. Dodge, David Orne, and S. K. Clark Washington, NASA, Oct. 1967 40 p refs
(Grant NsG-344)
(NASA-CR-900; TR-6) CFSTI: HC $3.00/MF $0.65 CSCL 20K

An elastic bar supported by a foundation exhibiting elasticity in shear serves as a model for determining the fore-and-aft stiffness properties of a pneumatic tire. The differential equation representing the deformation is derived and solved, and the resulting solution gives a means for calculating a fore-and-aft spring rate for the model. A series of five tires of various sizes and structures was used for testing the validity of the proposed model. A set of static tests was performed to establish an experimental value for the fore-and-aft spring-rate for the various tires. Additional structural data, required by the analytical solution of the model, were also obtained from the tires. A comparison of the calculated and experimental results was reasonably satisfactory, indicating that the proposed model can be used to roughly approximate fore-and-aft stiffness characteristics. A complete tabular summary of the geometry and composition of the five tires is included for easy reference. All experimental and analytical results are summerized and compared in graphical form. Author

N67-38632*# Whittaker Corp., San Diego, Calif. Narmco Research and Development Div.
RESEARCH STUDY OF COMMON BULKHEAD AND MANUFACTURING TECHNOLOGY IMPROVEMENT PROGRAM FOR SATURN STAGES Final Report, 23 Jun. 1966–23 Jun. 1967
Stephen Feher 23 Jun. 1967 45 p refs
(Contract NAS8-20376)
(NASA-CR-85369) CSCL 20K

The purpose of this study program was to determine the shear stress distribution in the adhesive layer of bonded joints, using photoelastic stress analysis techniques, and to establish the effect of joint configuration, bondline thickness, and adhesive modulus on the structural efficiency of bonded joints. Birefringent resin materials were evaluated for use as adhesives and coatings at room temperature and cryogenic temperature suitable for direct and indirect photoelastic analysis of the adhesive layer stress distributions. Experimental shear stress distribution data were obtained by the photoelastic technique on several joint configurations, using various adhesives. A theoretical stress analysis was also conducted so that results could be compared with experimental findings. Based on the results of this investigation, recommendations are made for the achievement of higher structural efficiency in bonded joint designs by optimization of configuration and proper selection of adhesives. Recommendations are also made for further experimental and analytical studies for the development of improved design and fabrication methods for bonded joints. Author

N67-38645# Bettis Atomic Power Lab., Pittsburgh, Pa.
SOME NOTES ON THE APPLICATION OF SYNTHESIS METHODS TO ELASTICITY PROBLEMS
S. Kaplan May 1967 34 p refs
(Contract AF(11-1)-GEN-14)
(WAPD-TM-694) CFSTI: HC $3.00/MF $0.65

Equations are derived for the application of the synthesis approach to the construction of approximate solutions of two and three dimensional elasticity problems using the solutions of one and two dimensional problems. An invariant imbedding type procedure is described for solving the equations. Author (NSA)

N67-38702# Sandia Corp., Albuquerque, N. Mex.
MEASUREMENT OF LONG-DURATION PRESSURE PULSES WITH SHORT PRESSURE BARS
R. I. Butler Jun. 1967 15 p ref Presented at the 12th Meeting on Interagency Mech. Operations Group, Subgroup on Environ. Testing, Richland, Wash.
(SC-R-67-1116; CONF-670213-1) CFSTI: HC $3.00/MF $0.65

If a pressure pulse is applied to the end of a long, slender, homogeneous bar of constant cross section, the pressure pulse will be transmitted down the bar as a stress pulse that duplicates the pressure pulse in shape, amplitude, and duration. If the bar is instrumented at some station, the strain-time (or stress-time) output of the instrumented section will describe the pressure input to the bar. Normally the arrival of the reflected pulse from the end of the bar would terminate the useful reading time of the pressure bar. If, however, the medium (usually a gas) in contact with the front of the bar has essentially zero acoustical impedance, and if the instrumented station is very close to the loaded end of the bar, the bar may be used to measure long-duration pulses with extremely short rise times. If the instrumented station consists of a piezo-electric wafer on the end of the bar, then, for a pulse that increases in amplitude linearly with time, the maximum percent error is t/2L, where t is the thickness of the wafer and L is the length of the bar. If the pulse contains an infinite slope, rise or fall, then the maximum error due to the reflected pulse would be 100%, but the duration of the reflected pulse would be only (X/2L)T, where T is the transit time of the pulse over the length

of the bar. Although many other sources of error are involved in making pressure measurements, only the errors due to reflection of the pressure pulses are discussed here. Author (NSA)

N67-38705 Laboratorio de Acustica e Sonica, Sao Paulo (Brazil).
SOUNDING OF STAINLESS STEEL CYLINDERS TO ASCERTAIN WALL THICKNESS [SONDAGEM DE CILINDROS DE ACO INOXIDAVEL PARA VERIFICACAO DA ESPRESSURA DA CHAPA]
L. X. Nepomuceno and W. Visentini 17 Nov. 1966 9 p refs In PORTUGUESE
(Rept.-6611.274)

The report describes the method, equipment, and accessories used in an ultrasonic determination of stainless steel wall thickness measurements. The results are presented in photographs and drawings of the cylinders, indicating thicknesses observed at different points. Author

N67-38794* North American Aviation, Inc., Downey, Calif. Space Div.
INFLUENCE OF STRUCTURE AND MATERIAL RESEARCH ON ADVANCED LAUNCH SYSTEMS' WEIGHT, PERFORMANCE, AND COST. APPENDIX D: WEIGHT AND COST DATA, PHASE II Interim Report, Jun. 30, 1966–Jun. 30, 1967
J. A. Boddy and J. C. Mitchell Aug. 1967 167 p
(Contract NAS7-368)
(NASA-CR-89271; SID-67-542-3) CSCL 22D

The cost subroutine and the component weight and complexity subroutine were used for the systematic evaluation of the six baseline expendable vehicles. Contained is the IBM program print-out data for the series of test cases. The results form a complete set of data for generation of any additional cost ratios required. It should be realized that the fabrication costs and material costs reflected in the data sheets do not constitute actual detail hardware costing data and should not be taken as official cost data. The data are only the results of an automated approach using the assumptions for fabrication complexities and material cost projections. Other values may be inputted, as available, at the user's option. The data are arranged into two distinct data banks. The first half contains information for the six vehicle systems showing how their structural components are affected by construction and material changes from the defined base point aluminum skin stringer. The information shows the component weight, cost and weight changes, and equivalent payload changes from the base point. Finally, a cost ratio is given of cost change to payload change. The remainder of the data bank indicates the cost makeup of the structural unit. Costs are assigned to the type of construction based on size, shape, and complexity, and the material costs (including parent stock costs if integral machining is involved). Author

N67-38853*# Jet Propulsion Lab., Calif. Inst. of Tech., Pasadena.
STIFFNESS MATRIX FOR A TRIANGULAR SANDWICH ELEMENT IN BENDING
H. C. Martin 1 Oct. 1967 32 p refs
(Contract NAS7-100)
(NASA-CR-85357; JPL-TR-32-1158) CFSTI: HC $3.00/MF $0.65 CSCL 13M

The finite element presented in this report is useful for analyzing plates and shells by the direct stiffness method. Both conventional thin plates and shells, as well as sandwich structures, are included. The stiffness matrix derivation is both simple and straightforward, since it is based on previously published material. A few examples are included to illustrate the accuracy obtained with this element. Author

N67-38940# Army Natick Labs., Mass. General Equipment and Packaging Lab.
GUIDE FOR ESTIMATING MAXIMUM ANCHOR LOADS ON AIR-SUPPORTED STRUCTURES
Thomas C. Strain and Ronald F. Tumeinski Mar. 1967 28 p
(TR-67-54-GP; AD-654789)

The report contains all the graphs, tables, mathematical formulas, and design data necessary to estimate the maximum loads on anchoring systems used with air-supported shelters subjected to winds up to 105 mph. The design data are presented in non-dimensional coefficient form. Sample problems are included to illustrate the use of the data and their application to both single and double-wall structures. Author (TAB)

N67-38996# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ENCYCLOPEDIA OF CONTEMPORARY ENGINEERING. STRUCTURAL MATERIALS. PART II: CORROSION FATIGUE THRU HASTELLOY
12 Apr. 1967 744 p Transl. into ENGLISH from Gos. Nauchn. Izd. Sov. Entsiklopediya (Moscow), v. 1–3, 1965
(Contract AF 33(657)-14184)
(FTD-TT-66-22, Pt. II; TT-67-62676; AD-657257)

The encyclopedia includes survey articles on the most important properties of heat-resistant, antiscaling, magnetic, semiconductor, corrosion-resistant, thermoacoustically insulating and other materials that are of greatest interest to workers in industry. An extensive section is devoted to modern testing and nondestructive quality-control methods for materials. Treatment of theoretical problems in physical metallurgy and material behavior in general is held to the necessary minimum; those interested in these problems are referred to the bibliographies given at the end of each article. Production processes are discussed only to the extent that they affect the properties of the materials. Author (TAB)

N67-38997# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ENCYCLOPEDIA OF CONTEMPORARY ENGINEERING. STRUCTURAL MATERIALS. PART III: HEAT AND SOUND INSULATING LOOSE FIBER MATERIALS THRU NICHROME
12 Apr. 1967 898 p Transl. into ENGLISH from Gos. Nauchn. Izd. Sov. Entsiklopediya (Moscow), v. 1–3, 1965
(Contract AF 33(657)-14184)
(FTD-TT-66-22, Pt. III; TT-67-62677; AD-657258)

The encyclopedia includes survey articles on the most important properties of heat-resistant, antiscaling, magnetic, semiconductor, corrosion-resistant, thermoacoustically insulating and other materials that are of greatest interest to workers in industry. An extensive section is devoted to modern testing and nondestructive quality-control methods for materials. Treatment of theoretical problems in physical metallurgy and material behavior in general is held to the necessary minimum; those interested in these problems are referred to the bibliographies given at the end of each article. Production processes are discussed only to the extent that they affect the properties of the materials. Author (TAB)

N67-39001# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ENCYCLOPEDIA OF CONTEMPORARY ENGINEERING. STRUCTURAL MATERIALS. PART I: ABLATION THRU CORDS
12 Apr. 1967 962 p Transl. into ENGLISH from Gos. Nauchn. Izd. Sov. Entsiklopediya (Moscow), v. 1–3, 1965
(Contract AF 33(657)-14184)
(FTD-TT-66-22, Pt. I; TT-67-62675; AD-657256)

The encyclopedia includes survey articles on the most important properties of heat-resistant, antiscaling, magnetic, semiconductor, corrosion-resistant, thermoacoustically insulating and other materials that are of greatest interest to workers in industry. An extensive section is devoted to modern testing and nondestructive quality-control methods for materials. Treatment of theoretical problems in physical metallurgy and material behavior in general is held to the necessary minimum; those interested in these problems are referred to the bibliographies given at the end of each article. Production processes are discussed only to the extent that they affect the properties of the materials. Author (TAB)

N67-39002# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ENCYCLOPEDIA OF CONTEMPORARY ENGINEERING. STRUCTURAL MATERIALS. PART IV: NICKEL THRU SOFT MAGNETIC MATERIALS

12 Apr. 1967 939 p Transl. into ENGLISH from Gos. Nauchn. Izd. Sov. Entsiklopediya (Moscow), v. 1–3, 1965

(Contract AF 33(657)-14184)

(FTD-TT-66-22, Pt. IV; TT-67-62678; AD-657259)

The encyclopedia includes survey articles on the most important properties of heat-resistant, antiscaling, magnetic, semiconductor, corrosion-resistant, thermoacoustically insulating and other materials that are of greatest interest to workers in industry. An extensive section is devoted to modern testing and nondestructive quality-control methods for materials. Treatment of theoretical problems in physical metallurgy and material behavior in general is held to the necessary minimum; those interested in these problems are referred to the bibliographies given at the end of each article. Production processes are discussed only to the extent that they affect the properties of the materials. Author (TAB)

N67-39003# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

ENCYCLOPEDIA OF CONTEMPORARY ENGINEERING. STRUCTURAL MATERIALS. PART V: SOLDER THRU ZIRCON

12 Apr. 1967 921 p Transl. into ENGLISH from Gos. Nauchn. Izd. Sov. Entsiklopediya (Moscow), v. 1–3, 1965

(Contract AF 33(657)-14184)

(FTD-TT-66-22, Pt. V; TT-67-62679; AD-657260)

The encyclopedia includes survey articles on the most important properties of heat-resistant, antiscaling, magnetic, semiconductor, corrosion-resistant, thermoacoustically insulating and other materials that are of greatest interest to workers in industry. An extensive section is devoted to modern testing and nondestructive quality-control methods for materials. Treatment of theoretical problems in physical metallurgy and material behavior in general is held to the necessary minimum; those interested in these problems are referred to the bibliographies given at the end of each article. Production processes are discussed only to the extent that they affect the properties of the materials. Author (TAB)

N67-39080*# Texas Univ., Austin. Dept. of Civil Engineering.

LOAD-SETTLEMENT BEHAVIOR OF GEOMETRIC SHAPES ON SILTY CLAY

Osman I. Ghazzaly and William R. Cox Aug. 1967 59 p refs

(Grant NsG-604)

(NASA-CR-66483) CSCL 20K

A series of static load settlement tests was performed on two circular plates, two spheres, and a cone on the surface of a silty clay in the field. Based on the experimental findings, empirical relations were established expressing the load-settlement and bearing capacity settlement behavior for the various foundation elements. These relations may be used to predict behavior for elements of different sizes under similar conditions. For circular plates a comparison is made of theoretical and experimental values of ultimate bearing capacity, immediate settlements, and modulus of subgrade reaction. A method is suggested for predicting the ultimate bearing capacity of a surface sphere in clay. Author

N67-39088*# Lehigh Univ., Bethlehem, Pa.

CRACK PROPAGATION THEORIES

Fazil Erdogan Washington, NASA, Oct. 1967 172 p refs

(Grant NGR-39-007-011)

(NASA-CR-901) CFSTI: HC $3.00/MF $0.65 CSCL 20K

This article consists of two parts. In the first part, crack propagation theories for brittle and quasi-brittle solids fracturing under a single application of the external loads are considered. Emphasis is on dynamic aspects of fracture phenomenon and related quantitative theories; thus, the problem is discussed only from the viewpoint of continuum mechanics and classical thermodynamics. Two theoretical approaches are presented in detail. These are: (1) the dynamic crack propagation theory based on the concept of modulus of cohesion proposed by Barenblatt, and (2) various forms of the energy balance theory based essentially on the ideas proposed by Griffith. A detailed analysis of the energy balance around the periphery of the crack is given and it is shown that the energy available at the crack periphery to create new fracture surfaces is equivalent to the crack closure energy, which is different from the released strain energy if the inertia effects are not negligible. Results are applied to plane extensional and anti-plane shear problems. The techniques used in obtaining results, and the results obtained from the available experimental studies are also discussed. In the second part, theories dealing with fatigue crack propagation in plates are considered. After a brief review of the existing models, a simple model based on plastic deformations around the crack tip is discussed. The model is intended to be largely a comparative tool in studying fatigue crack propagation in structures with the same material but different geometries and loading conditions. Results are used to analyze experimental results obtained from the plates under cyclic tension with variable mean loads and plates under cylindrical bending. Author

N67-39189 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NEWS OF INSTITUTIONS OF HIGHER LEARNING. AERONAUTICAL ENGINEERING

27 Apr. 1967 310 p refs Transl. into ENGLISH from Izv. Vyssh. Ucheb. Zaved., Aviats. Tekh. (Kazan), no. 1, 1964 p 1–190

(FTD-MT-64-288; TT-67-62350; AD-655358)

Summary of articles concerning aerodynamic characteristics of aircraft, gas turbines, flight vehicles, flight mechanics, and thermodynamics are presented. For individual titles see N67-39170–N67-39193.

N67-39172 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DESIGN V-SHAPED FOILS OF SMALL ASPECT RATIO BY THE METHOD OF HORSESHOE VORTICES [RACHET V-OBRAZNYKH KRYL'YEV MALOGO UDLINENIYA METODOM PODKOVOOBRAZNYKH VIKHREY]

B. V. Mirokhin *In its* News of Inst. of Higher Learning, Aeron. Eng. 27 Apr. 1967 p 23–35 refs (See N67-39189 23-32)

In the first part of this article, the author discusses the determination of the hydrodynamic characteristics of a V-shaped wing, simulating a vessel moving with heeling and drift, by means of the circulation-separation theory of a wing of small elongation. A V-shaped wing of small elongation is replaced by a vortex surface having an intensity which varies both in amplitude and in chord. The distribution of the vortex intensity over the wing can be determined on the basis of the condition of no liquid flow across its surface. It is shown that this condition yields an integral equation for the determination of the intensity distribution of vortices along the wing. Author

N67-39175 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

STABILITY OF A THREE-LAYER CYLINDRICAL SHEET WITH A LIGHT ORTHOTROPIC FILLER UNDER THE ACTION OF UNIFORM EXTERNAL PRESSURE [USTOYCHIVOST' TREKHSLOYNOY TSILINDRICHESKOY OBOLOCHKI S LEGKIM ORTOTROPNYM ZAPOLNITELEM POD DEYSTVIEM RAVNOMERNOGO VNESHNEGO DAVLENIYA]

N. K. Galimov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 65–74 refs (See N67-39169 23-32)

General stability of the shell under external hydrostatic pressure is analyzed and a formula is derived for critical load. The faces are considered to be different and isotropic, and the core lightweight and orthotropic (its transverse compressibility is disregarded). The effect of the variation of physical and geometric parameters of the shell (including the formation of waves) is discussed. All formulas and graphs are valid for $G/E \leq 0.01$, where G = the greatest shear modulus of the core and E = the smallest tension modulus of the faces. Author

N67-39176 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FREE VIBRATIONS OF CIRCULAR CONICAL AND CYLINDRICAL SHELLS REINFORCED BY ANNULAR RIBS OF RIGIDITY [SVOBODNYYE KOLEBANIYA KRUGOVYKH KONICHESKIKH I TSILINDRICHESKIKH OBOLOCHEK, PODKREPLENNYKH KOL'TSEVYMI REBRAMI ZHESTKOSTI]

V. G. Godzevich and O. V. Ivanova *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 75–83 refs (See N67-39169 23-32)

The author has considered the problem of free non-axiosymmetrical vibrations of circular, conical, and cylindrical shells reinforced by a set of annular stiffening ribs. The problem is solved by satisfying boundary conditions on the lines of contact of the ribs and shell. It is assumed that a circular, conical shell has k sections; that is, k−1 stiffening ribs. Author

N67-39177 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

NONSTATIONARY THERMAL CONDUCTION AND OPTIMUM PARAMETERS OF SANDWICH PLATES [O NESTATSIONARNOY TEPLOPROVODNOSTII OPTIMAL' NYKH PARAMETRAKH TREKHSLOYNYKH PLASTIN]

M. A. Il'gamov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 85–96 refs (See N67-39169 23-32)

In a brief introductory statement the author describes the structure of three-layer laminas and shells and reviews certain of their more salient properties. The contents of some seven articles on this general subject by other authors, whose papers are listed in the bibliography at the end of the paper, are outlined and their pertinence to the general problem area under consideration is indicated. The author considers non-stationary thermal conductivity in a lamina consisting of thin outer layers and a thermoinsulated filler. By a thermally thin layer is here to be understood a layer, throughout the thickness of which the temperature is rapidly equalized, with the order of thickness being determined on the basis of the criterion of skin thinness. The effect of the thin outer layers on the heating process of the lamina is evaluated by the thermal capacitances of these layers. Author

N67-39178 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

FREE VIBRATIONS OF A SPHERICAL DOME [SVOBODNYYE KOLEBANIYA SFERICHESKOGO KUPOLA]

R. L. Malkina *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 97–108 refs (See N67-39169 23-32)

Solutions of certain problems concerned with free vibrations of a spherical dome are expounded. On the basis of the investigations, equations are proposed with large indices of variability. Consideration is given to axially and uniaxially symmetric vibrations of a spherical dome, and to equations of frequencies. C.T.C.

N67-39187 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

APPLICATION OF LOGARITHMICALLY NORMAL DISTRIBUTION TO CALCULATIONS AND TESTS OF FATIGUE DURABILITY [PRILOZHENIYE LOGARIFMICHESKI-NORMAL'NOGO RASPREDELENIYA K RASCHETAM I ISLYTANIYAM USTALOSTNOY DOLGOVECHNOSTI]

Kh. B. Kordonskiy, B. Ye. Korsakov, and Yu. M. Paramonov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 201–211 refs (See N67-39169 23-32)

Pointing out that it has been demonstrated that the logarithmically-normal distribution of fatigue life can be successfully used for the elaboration of experimental data, the authors note that the application of this law of distribution to the investigation of fatigue life is as yet unclear. Fatigue accumulation may be considered, in the opinion of the authors, as a particular instance of wear accumulation at the occurrence of hardening, manifested in the gradual reduction of the rate of wear. The existence of hardening is directly confirmed in the form of the change in the hysteresis loop in the transition from cycle to cycle. Moreover, there is an indirect proof in the presence of the phenomenon of training, consisting in the reciprocal effect of stress levels on sum longevity. At low stresses, hardening occurs more slowly than under large loads, but more rapidly than the accumulation of fatigue faults. The effect of a small number of large loads, the probability of the development of a serious fatigue fault is small, while at the same time there occurs intensive hardening. This, in turn, makes it possible to increase longevity within a wide range of loads. Discussing a continuous system of fatigue fault accumulation, the authors note that the most general phenomenological description of fatigue accumulation may be represented in the form of an integral. Author

N67-39188 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

THEORETICAL INVESTIGATION OF THE PROCESS OF BENDING WITH CALCULATION OF FORMATION OF ZONES OF SECONDARY PLASTIC DEFORMATIONS DURING UNLOADING [TEORETICHESKOYE ISSLEDOVANIYE PROTSESSA GIBKI S UCHETOM OBRAZOVANIYA ZON VTORICHNYKH PLASTICHESKIKH DEFORMATSIY PRI RAZGRUZKE]

Yu. P. Katayev and M. I. Lysov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 213–222 refs (See N67-39169 23-32)

The authors note that the molding of cylindrical parts by the method of plastic bending is accompanied by a reduction of the curvature after relief of the load. This phenomenon, known as springing, reduces the accuracy of the molding process. The present paper deals with the problem of the scope of applicability of analytical methods for the calculation of this phenomenon of springing, based on the so-called load relief theorem. This theorem proceeds from the assumption that the secondary strains and stresses, opposite in sign, which arise at the time of load relief in the outer sectional zones, do not exceed the elastic limit of the material. It is in the light of this premise that the authors have considered a theoretical solution of the problem of springing. Author

N67-39189 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

CALCULATION OF CONTROLLED COORDINATES OF POINTS OF FRAME AND RULED SURFACES OF FLIGHT VEHICLES [RASCHET UPRAVLYAEMYKH KOORDINAT TOCHEK KARKASNYKH I LINEYCHATYKH POVERKHNOSTEY LETATEL'NYKH APPARTOV]

V. A. Osipov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 223–234 refs (See N67-39169 23-32)

The author notes that in recent times countersink-drilling equipment with programmed control has been developed for use in finishing longitudinal and transverse welded joints in panels of single and double curvature. In order that a program calculation algorithm can be written for the finishing of these joints, working formulas are required to compute the travel of the movable elements of the equipment according to the base data of theoretical and working drawings. The author has briefly described a method for solving the fundamental problems, as well as the derivation of the equations and formulas with allowance for the specific character of the assigned axes of the assemblies and equipment. Author

N67-39191 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

DERIVATION OF EQUATIONS OF A PLANE PROBLEM OF THE THEORY OF ELASTICITY IN OBLIQUE COORDINATES [K VYVODU URAVNENIY PLOSKOY ZADACHI TEORII UPRUGOSTI V KOSOUGOL'NYKH KOORDINATAKH]

M. B. Vakhitov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 241–249 refs (See N67-39169 23-32)

The present paper deals with the derivation, by means of tensor analysis, of a complete system of equations for a plane problem of the elasticity theory in oblique-angle coordinates, and also of formulas for the conversion of stress and deformation components. Equations of the classic theory of elasticity (that is, with small deformations) are considered. In a concluding section, a transition is made from tensor nomenclature to physical components and the nomenclature current in the applied theory of elasticity. Author

N67-39192 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

RESEARCH ON VIBRATIONS OF BARS WITH HOLES [ISSLEDOVANIYE KOLEBANIY STERZHNEY S OTVERSTIYAMI]

V. A. Sidorov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 251–258 refs (See N67-39169 23-32)

Pointing out that many aircraft assemblies consist of parts with apertures and slots, the author notes that there is a lack of information in contemporary technical literature concerning the vibrations of such structures. The present paper presents a method for the calculation of the natural frequencies of the transverse vibrations of rods with apertures. The "equivalent rod" method is employed. The equivalent rod must have uniform strength along its entire length and the same frequency as the rod with apertures. Once the length of the equivalent rod is found, a well-known simple formula can be used to determine its frequency. Author

N67-39196# Sandia Corp., Albuquerque, N. Mex.

STABILITY OF MULTILAYERED ORTHOTROPIC CYLINDRICAL SHELLS SUBJECTED TO COMBINED AXIAL COMPRESSION AND LATERAL EXTERNAL PRESSURE

T. G. Priddy, R. D. Hoagland, and H. R. MacDougall Jul. 1967 48 p refs

(Contract AT(29-1)-789)

(SC-TM-67-519) CFSTI: HC $3.00/MF $0.65

The theory, computer program, and use conditions for the determination of the elastic stability of composite orthotropic cylinders subjected to combined radial and axial loading are described. Author (NSA)

N67-39293# Oak Ridge National Lab. Metals and Ceramics Div.

YIELD STRESS AND PLASTIC STRAIN THEORY FOR ANISOTROPIC MATERIALS

D. C. Bogue Jul. 1967 41 p refs

(Contract W-7405-ENG-26)

(ORNL-TM-1869) CFSTI: HC $3.00/MF $0.65

A yield stress and plastic strain theory is developed for anisotropic materials that show the Bauschinger effect. The theory is a generalization of Hill's anisotropic theory. The quadratic (Hill) terms are common to and predominate in both the yield stress criterion and the plastic strain equations; there are additional constants in both cases that are not interrelated. The formulation is motivated by the behavior of Zircaloy-2 and provides a good correlation of experimental data from a highly textured material. Author (NSA)

N67-39312*# General American Transportation Corp., Niles, Ill. Research Div.

TRANSPORTATION AND HANDLING SHOCK AND VIBRATION ENVIRONMENTAL CRITERIA

Fred E. Ostrem and M. L. Rumerman 28 Apr. 1967 119 p refs

(Contract NAS8-11451)

(NASA-CR-84408; MR-1262-2) CFSTI: HC $3.00/MF $0.65 CSCL 20K

A comprehensive literature survey and search was conducted for data and information applicable to the cargo handling environment. Approximately 150 reports and articles were reviewed and over 50 agencies or organizations concerned with problems of this nature were contacted. The information compiled is summarized to show the distribution of drop heights for particular packages, distribution systems, and handling operations. Other information on the handling environment such as the number of drops received per package per trip, the distribution of the drops over the faces, edges and corners, the effect of package size and weight, the effect of the distribution system and the effect of labels and handholds are also presented. A case history for paper sacks is presented which describes the complete drop height history from manufacturer to customer. Applications of the data to typical package design problems are discussed. Results of recent measurement programs of the transportation shock and vibration environment are also presented. Author

N67-39328*# Stanford Univ., Calif.

THEORETICAL STUDIES OF SOME NONLINEAR ASPECTS OF HYPERSONIC PANEL FLUTTER Status Report No. 4, 1 Mar.–31 Aug. 1967

K. Karamcheti 31 Aug. 1967 14 p

(Grant NGR-05-020-102)

(NASA-CR-89268) CFSTI: HC $3.00/MF $0.65 CSCL 20K

The case of a two-dimensional panel, or plate-column, is considered in a study of the effects of aerodynamic nonlinearity. The supports are hinged, and their in-plane motion is resisted by a distributed spring. Free-stream parameters are shown. The panel is loaded by an applied in-plane load, a static pressure difference, and an unsteady pressure difference. The second-order piston-theory expression is given for the unsteady pressure approximation in hypersonic flow. S.P.

N67-39361*# North American Aviation, Inc., Downey, Calif. Space Div.
INFLUENCE OF STRUCTURE AND MATERIAL RESEARCH ON ADVANCED LAUNCH SYSTEMS' WEIGHT, PERFORMANCE, AND COST, VOLUME II, PHASE II Interim Report
J. A. Boddy and J. C. Mitchell Aug. 1967 435 p refs
(Contract NAS7-388)
(NASA-CR-89270; SID-67-542-2) CSCL 22D

The second phase of the program was devoted to extending the structural design synthesis analyses initiated during the first phase to include advanced types of structural concepts. These concepts were applied to the series of baseline expendable launch vehicle systems of the first phase to determine beneficial structures and materials research areas. A technique was developed for the parametric synthesis of expendable winged body first stages and six representative vehicle systems were defined for future study. A plan developed for turning over the first phase computer programs to NASA is discussed in detail. Also included are the results of a brief study conducted to evaluate the feasibility of the parametric synthesis of reentry vehicles. R.N.A.

N67-39374# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
APPLIED MECHANICS Selected Articles
20 Jan. 1967 25 p refs Transl. into ENGLISH from Prikl. Mekh., Akad. Nauk Ukr. RSR (Kiev), v. 1, no. 2, 1965 p 10–17, 129–134
(FTD-TT-66-31; TT-67-62281; AD-655028)

CONTENTS:
1. DYNAMIC STABILITY OF LONGITUDINALLY CORRUGATED CYLINDRICAL SHELLS G. L. Komissarova p 1–10 refs (See N67-39375 23-32)
2. SOLUTION OF THE PROBLEM OF ANTISYMMETRIC DEFORMATION OF A CONICAL SHELL OF LINEARLY VARIABLE THICKNESS ON A 2M FAST ELECTRONIC COMPUTER Ya. M. Grigorenko and T. I. Polishchuk p 11–19 refs (See N67-39376 23-32)

N67-39375# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DYNAMIC STABILITY OF LONGITUDINALLY CORRUGATED CYLINDRICAL SHELLS [DINAMICHESKAYA USTOYCHIVOST' PRODOL'NO GOFRIROVANNYKH TSILINDRICHESKIKH OBOLOCHEK]
G. L. Komissarova *In its* Appl. Mech. 20 Jan. 1967 p 1–10 refs (See N67-39374 23-32)

A longitudinally corrugated cylindrical shell is treated as an equivalent anisotropic plain cylindrical shell with properly reduced elastic characteristics. The dynamic stability of such an equivalent shell, hinged at the ends and subject to longitudinal time variable compressive loading uniformly distributed along the edges, is analyzed using the V. Z. Vlasov engineering shell theory for the derivation of differential equations, and the B. G. Galerkin variational method for solving these equations in nonlinear formulation and determining the first regions of dynamic instability. An equation for the amplitude frequency characteristics and an expression for the minimum value of the excitation parameter at which the generation of undamped vibrations is possible are presented. The results of a numerical dynamic stability analysis of a longitudinally corrugated cylindrical shell and of a plain shell are compared in an amplitude frequency diagram; the dynamic instability region and the excitation parameter for both shells are discussed. Author

N67-39376# Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
SOLUTION OF THE PROBLEM OF ANTISYMMETRIC DEFORMATION OF A CONICAL SHELL OF LINEARLY VARIABLE THICKNESS ON A 2M FAST ELECTRONIC COMPUTER [RESHENIYE ZADACHI OB ANTISIMMETRICHNOY DEFORMATSII KONICHESKOY OBOLOCHKI LINEYNOPEREMENNOY TOLSHCHINY NA BESM-2M]
Ya. M. Grigorenko and T. I. Polishchuk *In its* Appl. Mech. 20 Jan. 1967 p 11–19 refs (See N67-39374 23-32)

The deformation of a thin, variable thickness, conical shell under an antisymmetric boundary load was studied analytically. The shell thickness varies linearly and the applied loads are both self-balancing and nonself-balancing. The shear stresses are represented as sums of real and imaginary parts of complex hypergeometric functions. The hypergeometric functions are then represented in terms of power series. Error in the partial sum is also determined. The solution was carried out in three steps in which were considered: (1) a solution corresponding to a self-balancing load in the interval $0<x<1$; (2) the same solution as (1) with the exception that $x=0$ and $x=1$; and (3) a solution corresponding to a nonself-balancing load in the interval $0\leq x\leq 1$. Special solutions were also obtained using the proposed method. Author

33 THERMODYNAMICS AND COMBUSTION

Includes ablation, cooling, heating, heat transfer, thermal balance, and other thermal effects; and combustion theory. For related information see also: 12 Fluid Mechanics; and 27 Propellants.

N67-38116# Marine Engineering Lab., Annapolis, Md.
A STUDY OF THE TEMPERATURE DISTRIBUTIONS AND HEAT GENERATION RATES OF A PAIR OF BALL BEARINGS UNDER AXIAL LOAD
Joseph I. Schwartz (M.S. Thesis) Aug. 1967 129 p refs
(MEL-2458; AD-657117)

The thesis presents an analytical and experimental study of the thermal characteristics of light to moderately loaded ball bearings. Included are the results of a literature search, a theoretical analysis, and experimental results. A comparison between theory and experiment shows that the trends of the analytical prediction of heat generation rates and temperature distributions of an operating bearing is possible, however, the precision is of the order of 25% or worse. Other conclusions concerning the validity of the theory are discussed and recommendations for further work are presented. Author (TAB)

N67-38241# North Carolina State Coll., Raleigh.
DYNAMICS AND THERMODYNAMICS OF VISCOELASTIC MEDIA Final Report
P. H. McDonald Jun. 1967 75 p refs
(Contract DA-01-009-ORD-991)
(AD-656943)

A fundamental thermodynamic theory was developed which is applicable to the class of materials and regimes of excitation intended in the object of the study. An experimental apparatus was designed, constructed and operated for the purpose of measuring the relevant and significant materials properties. A particular material, a room-temperature-vulcanizing rubber, was studied quantitatively in the range 5 to 25 KHz. Author (TAB)

N67-38281*# National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
TRANSIENT HEAT CONDUCTION IN FINITE SLABS WITH POSITION-DEPENDENT HEAT GENERATION
Roy W. Miller Washington, NASA, Oct. 1967 36 p refs
(NASA-TM-X-1442) CFSTI: HC$3.00/MF$0.65 CSCL 20M

Transient heat conduction in a slab of finite thickness is analyzed so as to include the effect of position-dependent heat generation. One face of the slab is a convecting surface, and the other is considered to be insulated. Temperature distributions are obtained for the cases of constant, linear, exponential, and cosinusoidal heat-production rates. The solutions are obtained by the integral transform method and are in terms of Fourier series. Numerical values of these series were calculated and are presented graphically, in dimensionless form, so that specific cases can be easily computed. The method of solution is outlined in detail so that temperature distributions can be obtained for other position-dependent heat-generation rates. Author

N67-38507# Little (Arthur D.), Inc., Cambridge, Mass.
DEVELOPMENT OF HIGH TEMPERATURE THERMAL CONDUCTIVITY STANDARDS Technical Report, 3 May 1965–3 Nov. 1966
Alfred E. Wechsler Wright-Patterson AFB, Ohio, AF Mater. Lab., Jan. 1967 148 p refs
(Contract AF 33(615)-2874)
(AFML-TR-66-415; AD-657024)

An analytical and experimental study was proposed to establish high temperature thermal conductivity and diffusivity standards and to test these standards. The report describes the identification, selection, characterization and preliminary experimental examination of candidate standard materials for use in the subsequent measurement program. Based on criteria such as phase change, melting point, reproducibility, isotropy, fabricability, homogeneity, and availability, the following materials were selected for experimental evaluation: ceramics--alumina, beryllia, thoria, calcium zirconate, and yttria-stabilized zirconia; intermetallics--silicon carbide, boron carbide, titanium carbide, and zirconium diboride; metals--molybdenum, tantalum, tungsten, tantalum-10% tungsten, and molybdenum-30% tungsten; graphites--ATJ, CEQ, RVD, PO-3, DS-13, 1924-H, 7890, XUT-31, and UF4S. Samples of these materials were obtained in sizes similar to those used in thermal conductivity and diffusivity apparatus. The experimental evaluation consisted of visual examination, density measurements, microstructural examination, heating tests simulating the environment and temperature cycling encountered in thermal property measurements, preliminary thermal conductivity measurements, and preliminary electrical resistivity measurements. Based upon the experimental results, aluminum oxide, thorium oxide, arc cast tungsten, and grades 1924-H (or AXM-5Q1) and RVD graphites were selected for the Phase II measurements program. Author (TAB)

N67-38543# Thermo Electron Engineering Corp., Waltham, Mass.
RESEARCH AND DEVELOPMENT OF VACUUM FOIL-TYPE INSULATION FOR RADIOISOTOPE POWER SYSTEMS Quarterly Progress Report, Nov. 1966–Jan. 1967
J. B. Dunlay, J. Fronduto, M. L. Paquin, and V. L. Poirier 28 Apr. 1967 116 p
(Contract AT(30-1)-3634)
(ALO-3634-04; QPR-4) CFSTI: HC$3.00/MF$0.65

Progress is reported on the development of high temperature thermal insulation. Planar heat transfer test results are presented for W–ThO_2 insulation samples. Spray coating techniques are described for applying thin oxide layers to refractory metal foils. Designs are shown for cylindrical thermal conductivity and edge heat loss test assemblies. Preliminary results are given for heat losses through Re support insulation configurations. Life test results are presented on the thermal and outgassing characteristics of insulation samples after 100 hours and 500 hours of operation at 1700°C and 1900°C. Author (NSA)

N67-38573# Aerojet-General Nucleonics, San Ramon, Calif. Nuclear Products and Services Group.
ALKALI METALS EVALUATION PROGRAM. VISCOSITY OF LIQUID SODIUM AND LITHIUM
P. Y. Achener and D. L. Fisher May 1967 49 p refs
(Contract AT(04-3)-368)
(AGN-8191, Vol. 5) CFSTI: HC$3.00/MF$0.65

Viscosity of liquid Na and Li at temperatures from the melting points to 1040 and 878°C, respectively, are reported. The experimental method involved the use of an oscillating cylinder viscometer. The equations proposed for the absolute viscosity of Na and Li are, respectively: $\log_{10}\mu = 3.25538 - 10.4126/T - 0.96843 \log_{10}T$ and $\log_{10}\mu = 1.310 + 225.4/T - 0.3478 \log_{10}T$, where μ is in millipoises and T in degrees Kelvin. Author (NSA)

N67-38580*# National Aeronautics and Space Administration, Washington, D. C.
THERMAL INSULATION SYSTEMS, A SURVEY
Peter E. Glaser (Little (Arthur D.), Inc.), Igor A. Black (Little (Arthur D.), Inc.), Richard S. Lindstrom (Little (Arthur D.), Inc.), Frank E. Ruccia (Little (Arthur D.), Inc.), and Alfred E. Wechsler (Little (Arthur D.), Inc.) Washington, NASA, 1967 154 p refs Prepared by Little (Arthur D.), Inc., Cambridge, Mass.
(NASA-SP-5027) CSCL 20M

A survey is made of data on the performance of thermal insulations and systems combining such insulations, particularly for cryogenic applications. The discussion covers the possible applications of thermal insulation systems in industry, the principles of thermal protection systems, the installation and materials of cryogenic insulations systems, the structural and noninsulating cryogenic system components, and high temperature protections systems for spacecraft structures, thrust chambers, and other spacecraft components. R.N.A.

N67-38592# Air Force Systems Command, Wright-Patterson AFB, Ohio. Air Force Flight Dynamics Lab.
CRYOGENIC HEAT PIPE Final Report, Mar.–Dec. 1966
William L. Haskin Jun. 1967 59 p refs Prepared Jointly with Ohio State Univ.
(AFFDL-TR-66-228; AD-657025)

A heat pipe is a metal tube containing a two phase fluid to transport heat over several feet by evaporating liquid at the warm end and condensing the vapor at the cold end. An experimental heat pipe was constructed and instrumented to permit measurements of the heat transport in a nitrogen vapor tube wherein the vapor pressure and boundary temperatures could be monitored. No major effort was made to optimize the performance of the tube tested, but various designs and operating parameters were investigated experimentally to determine their effects on the thermal impedance of the tube. Heat loads of up to 130 watts were transferred axially in this 3/4-inch OD, 33-inch-long heat pipe with less than half the total temperature drop required by a copper rod of comparable size. The main temperature drops in the heat pipe are due to heat conduction through the tube wall and the fluid filled wick liner of the evaporator and condenser sections. When the tube surface temperatures were near the critical temperature of nitrogen, vapor film formation caused a large temperature drop. Author (TAB)

N67-38607# Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.

TOODEE: A TWO-DIMENSIONAL, TIME-DEPENDENT HEAT CONDUCTION PROGRAM

John A. McClure Apr. 1967 167 p refs

(Contract AT(10-1)-205)

(IDO-17227) CFSTI: HC $3.00/MF $0.65

TOODEE is a two-dimensional, time-dependent heat conduction computer program written in the FORTRAN IV and MAP languages. This program is suitable for investigating general transient and/or steady-state problems. Typical of (but not limited to) the types of problems for which the program has been used are the calculation of temperature distributions in reactor fuel elements during power excursions. The mesh for the program is formed by variably spaced orthogonal curves in either slab or cylindrical geometry. The cylindrical geometry may be either axisymmetric, with space variables R–Z, or polar, with space variables R–θ. Conditions to be specified independently at each boundary are either surface temperatures or heat transfer coefficients and either exterior temperatures or flow rates. Materials and coolant properties required in the program are evaluated from FORTRAN arithmetic functions supplied by the user. These properties may be time and/or temperature dependent. In addition, nonisotropic thermal conductivities and expansion coefficients may be defined. Phase changes are permitted in all materials except coolants. Author (NSA)

N67-38623# Los Alamos Scientific Lab., N. Mex.

DETONATION THEORY AND EXPERIMENT

W. C. Davis and W. Fickett [1967] 11 p refs Presented at the Intern. Symp. on the Behavior of Dense Media under High Impulsive Pressures, Paris

(Contract W-7405-ENG-36)

(LA-DC-8405; CONF-670914-3) CFSTI: HC $3.00/MF $0.65

Theoretical work on the detonation theory dealing with unsupported detonation in liquid and solid explosives and restricted to high-order detonation in which the reaction is nearly steady (independent of time in a reference frame moving with the front), and in which the detonation front is nearly plane is reveiwed and compared, where possible to experimental results. It appears that the Chapman–Jouguet theory provides an adequate approximation since the adjustability of the equation of state parameters accommodates the defects in the flow theory. NSA

N67-38646# Bettis Atomic Power Lab., Pittsburgh, Pa.

HOT-2: A TWO-DIMENSIONAL TRANSIENT HEAT CONDUCTION PROGRAM FOR THE CDC-6600

W. D. Peterson and J. Spanier Jun. 1967 279 p refs

(Contract AT(11-1)-GEN-14)

(WAPD-TM-669) CFSTI: HC $3.00/MF $0.65

HOT-2 is a digital computer program to solve two-dimensional plane and axially symmetric steady-state and transient heat conduction problems with diagonal boundaries and interfaces. Mesh spacing (at most 5000 points) is completely variable. As many as 99 regions are permitted in order to describe spatial variations in material properties, heat generation rates, and boundary conditions. The heat generation rate and boundary conditions may vary with time. The alternating direction iterative method is used to solve the difference equations, both for transient and steady-state calculations. Author (NSA)

N67-38686# Aix-Marseilles Univ. (France). Institut de Mecanique des Fluides.

APPLICATION OF THE METHOD OF SODIUM D LINE-REVERSAL TO MEASURE NITROGEN VIBRATION TEMPERATURES BEHIND AN EXPANDED SHOCK AND AFTER RELAXATION IN A NOZZLE [APPLICATION DE LA METHODE DE RENVERSEMENT DES RAIES D DU SODIUM A LA MESURE DES TEMPERATURES DE VIBRATION DE L'AZOTE DERRIER UN CHOC EN PROPAGATION ET APRES DETENTE DANS UNE TUYERE]

H. Guenoche and R. Chareyre *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 111–130 refs In FRENCH (See N67-38681 23-06)

The observed time history of the sodium D-line reversal temperatures and nitrogen vibrational temperatures are described. The observed sodium temperature profile and the calculated nitrogen vibrational temperature are compared. Data on the evolution of the temperatures are graphed. It is concluded that the sodium temperature development behind the shock wave is not the same as that of the nitrogen vibrational temperature, implying that the sodium atoms are not excited by collisions with vibrationally excited nitrogen molecules. N.E.R.

N67-38689# College of Aeronautics, Cranfield (England).

SHOCK REFLECTION AND SURFACE EFFECTS IN THE SHOCK TUBE

J. R. Busing and John F. Clarke *In* AGARD Recent Advances in Aerothermochem., Vol. 1 1967 p 165–190 refs (See N67-38681 23-06)

A thin-film resistance thermometer, mounted on the end-wall of a shock tube, is used to record surface temperatures and heat transfer rates following reflection of the primary shock wave. This information is combined with the results of theoretical investigations to produce simultaneous information about surface accommodation effects and gas thermal conductivities at high pressures and moderate temperatures. Author

N67-38710# TRW Systems, Redondo Beach, Calif.

INVESTIGATION OF THE ABLATION OF SMALL PARTICLES UPON SIMULATED RE-ENTRY Final Report

J. C. Slattery and E. Tagliaferri Feb. 1967 44 p refs Prepared for Sandia Corp.

(SC-CR-67-2583) CFSTI: HC $3.00/MF $0.65

Results obtained from a research program on the behavior of small particles under conditions simulating reentry into the atmosphere are summarized. Using particles with diameters on the order of one micron, measurements were made of the heat transfer and drag coefficients of silver and iron particles interacting with target gases of air, argon, nitrogen, and oxygen. Measurements were made in the free molecule flow regime for nonablating iron and silver particles, and for ablating iron particles. Measurements were also made for iron particles in the transition flow regime using an air target. Author (NSA)

N67-38838 Massachusetts Inst. of Tech., Cambridge. Mechanical Engineering Dept.

THERMAL NON-EQUILIBRIUM IN DISPERSED FLOW FILM BOILING IN A VERTICAL TUBE

Robert P. Forslund and Warren M. Rohsenow Nov. 1966 164 p refs

(Grant NSF GK-39)

(TR-75312-44)

The departure from thermal equilibrium between a dispersed liquid phase and its vapor at high quality during film boiling is investigated. The departure from equilibrium is manifested by the high resistance to heat transfer between the dispersed and continuous phases, which results in much higher vapor temperatures and a defect in the amount of vapor generated. The effect on the overall heat transfer is to raise the tube wall temperature, and incomplete evaporation occurs within the tubes. Film boiling tests with liquid nitrogen ($70{,}000 \leq G \leq 190{,}000$ lbm/hr/ft^2 and $5000 \leq q/A \leq 25{,}000$ Btu/hr/ft^2) were made with 0.228, 0.323, and 0.482 inch ID tubes, 4 and 8 foot long. The non-equilibrium quality was measured experimentally by a helium tracer gas technique. A kinematic-heat transfer analysis of the core flow confirmed the trends in the departure from equilibrium. Film boiling pressure drop is also reported. Author

N67-38856# General Electric Co., Schenectady, N. Y. Research and Development Center.

CIRCUMFERENTIAL NONUNIFORM HEATING DURING TRANSITION ON A SLENDER CONE AT HYPERSONIC MACH NUMBERS

H. T. Nagamatsu, D. C. Wisler, and R. E. Sheer, Jr. Jul. 1967 43 p refs

(Rept.-67-C-272)

An experimental investigation was conducted to study nonuniform heating rates during laminar boundary layer transition on a 4 foot 10° cone. The Mach number outside the boundary layer was 9.6 and the wall to stagnation temperature ratio was 0.214. Four sputtered platinum wedge heat transfer probes were used to survey the boundary layer at 0°, 90°, 180°, and 270° at 34.5 inches from the cone tip. In the laminar region there was no evidence of nonuniform heating rates. However, a small oscillation at all circumferential positions was observed near the outer edge of the boundary layer indicative of the location of the critical layer. For the transition and turbulent boundary layer there were indications of large nonuniform heating rates as much as 100% near the wall. In addition, the heating rates in the circumferential direction varied with time. Author

N67-38872# Dynatech Corp., Cambridge, Mass.

INVESTIGATION OF BOILING FLOW REGIMES AND CRITICAL HEAT FLUX Quarterly Progress Report, Aug. 1, 1966–Mar. 15, 1967

A. E. Bergles, J. P. Roos and J. G. Bourne 21 Jun. 1967 35 p refs

(Contract AT(30-1)-3304)

(NYO-3304-10) CFSTI: HC $3.00/MF $0.65

A detailed survey of reported experiments utilizing two-phase steam–water mixtures at the test-section inlet is presented. It is concluded that upstream and inlet-mixing instabilities must be avoided if the data are to be reliable. An annular inlet-mixing arrangement appears to yield critical heat flux data which are in close agreement with subcooled-inlet data, providing that the total test-section length is sufficiently long. The results of present tests utilizing a controllable annular mixer and a 0.4-in. diameter, 59-in. long test section, can be summarized as follows: adiabatic flow regime maps differ substantially from diabatic flow regime maps; however, in the adiabatic case, the entering phase distribution is of critical importance in determining what the flow regime will be at the test-section exit; for minimum flow pattern distortion, the steam and water feed flows must be close to the saturation condition; flow-regime and film-thickness measurements indicate that the entering water velocity must be controlled to establish a flow pattern comparable to that which would exist if subcooled inlet conditions were used; and film flow rate and critical heat flux behavior for mixed-inlet conditions appear to be comparable to that observed for subcooled inlet conditions if the mixer is properly adjusted. Author (NSA)

N67-38921# General Electric Co., Philadelphia, Pa. Missile and Space Div.

THEORETICAL STUDIES OF THE RE-ENTRY OF PLUTONIUM FUEL

L. M. Gilbert, R. Liner, S. M. Scala, and F. L. Schuyler Jun. 1967 130 p refs Prepared for Sandia Corp.

(Contract AT(29-1)-789)

(SC-CR-67-2573) CFSTI: HC $3.00/MF $0.65

The reentry response of small particles was calculated. The development of a theory for the melting of small particles under hypersonic reentry conditions and the development of analyses for predicting the stability of thin liquid layers on spheres and the conditions under which fully molten particles will break up are included. Based on these analyses, predictions of instability and mass loss were made for 50 and 250 micron diameter particles of plutonium dioxide for two specified release conditions.

Author (NSA)

N67-38991# Aerojet-General Nucleonics, San Ramon, Calif. Nuclear Products and Services Group.

ALKALI METALS EVALUATION PROGRAM. THE SPECIFIC HEAT OF LIQUID SODIUM AND LITHIUM

P. Y. Achener and D. L. Fisher Jun. 1967 39 p refs

(Contract AT(04-3)-368)

(AGN-8191, Vol. 6) CFSTI: HC $3.00/MF $0.65

The enthalpy and specific heat of liquid Na and Li were determined at temperatures between 250 and 2150°F for sodium, and between 250 and 2100°F for lithium using a Bunsen ice calorimeter. The equation proposed for the enthalpy of Na from near the melting point to 2150°F is: $H_T^o - H_{32°F}^o = 44.50 + 0.3168T$ Btu/lb where T is in degrees Fahrenheit. The resulting value for the specific heat of liquid Na is: $C_p = 0.3168$ Btu/lb/°F. The equations proposed for the enthalpy of Li are: $H_T^o - H_{32°F}^o = -27.7 + 0.859T$ Btu/lb from 32° to 357°F (melting point), and $H_T^o - H_{32°F}^o = 66.42 + 1.148T - 1.010 \times 10^{-4}T^2 + 2.184 \times 10^{-8}T^3$ Btu/lb from 357°F to 2100°F. The latent heat fusion was calculated from these equations; the value is 185.5 Btu/lb. The resulting value for the specific heat of liquid lithium is: $C_p = 1.148 - 2.019 \times 10^{-4}T + 6.553 \times 10^{-8}T^2$ Btu/lb/°F where T is in degrees Fahrenheit. Author (NSA)

N67-38994# National Engineering Lab., Glasgow (Scotland).

THE PREDICTION OF THE PERFORMANCE OF CONDENSER NESTS WITH BY-PASS LANES

M. H. Choudhury and M. W. Mac Farlane Feb. 1967 34 p refs

(NEL-274)

The influence on the predicted performance of a condenser of the velocity distribution of the vapor-gas mixture on the shell side of the tube nest is examined using a digital computer. The influence of steam by-passing the nest at the wall is shown to have a significant influence on the distribution of noncondensable gas in the nest and on the variation in heat flux throughout the condenser. The limitations of the procedure used are discussed and it is concluded that accurate prediction of the distribution of heat flux during condensation in a tube nest requires a two-dimensional solution of the equations. Author

N67-38995# Aerojet-General Nucleonics, San Ramon, Calif. Nuclear Products and Services Group.

ALKALI METALS EVALUATION PROGRAM. THE VAPOR PRESSURE OF LITHIUM

P. Y. Achener and D. L. Fisher Jul. 1967 21 p refs

(Contract AT(04-3)-368)

(AGN-8191, Vol. 2) CFSTI: HC $3.00/MF $0.65

Vapor pressure of lithium was determined at temperatures from 1881 to 2286°F and pressures from 0.96 to 7.86 psia. Although experimental difficulties prevented extension of the work to higher temperatures, the data agree with those of other investigations. Author (NSA)

N67-39079# Los Alamos Scientific Lab., N. Mex.

THERMODYNAMICS OF THE PLUTONIUM CARBIDES

W. M. Olson and R. N. R. Mulford [1967] 19 p refs Presented at the Symp. on Thermodyn. of Nucl. Mater. with Emphasis on Soln. Systems, Vienna

(Contract W-7405-ENG-36)

(LA-DC-8012; CONF-670915-1) CFSTI: HC $3.00/MF $0.65

The results of volatility measurements on samples from portions of the Pu–C system and attempts to derive the thermodynamic properties of some of the Pu carbide phases are presented. The values for thermodynamic functions of the plutonium carbides were compared with those of the isostructural uranium carbides. The absolute entropies of $UC_{1.5}$ and $PuC_{1.5}$ agreed very closely, but the absolute entropy of $PuC_{0.87}$ was substantially higher than that of $UC_{1.0}$. The results are discussed. NSA

N67-39132# North Carolina Univ., Chapel Hill.
THERMODYNAMICS OF ION EXCHANGE ON COLLOIDAL MATERIALS WITH APPLICATIONS TO SILICATE MINERALS Final Report
Henry C. Thomas Mar. 1967 87 p refs
(Contract AT(40-1)-2130)
(TID-23908) CFSTI: HC $3.00/MF $0.65

Thermodynamics of interfacial regions are discussed, including a review of some necessary parts of classical thermodynamics followed by a detailed development of the application to surface regions. Ion exchange on clay minerals is used to give illustrations of the use of the results. Examples of the great simplifications that must be made in the application of equilibrium data to flow through beds of ion exchangers are given to illustrate approximate applications to flowing systems. NSA

N67-39170 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
ON THE ACCURACY OF NUMERICAL CALCULATION OF AERODYNAMIC HEATING OF A COVERING [O TOCHNOSTI CHISLENNOGO RASCHETA AERODINAMICHESKOGO NAGREVA OBSHIVKI]
V. S. Zarubin *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 1–12 refs (See N67-39169 23-32)

The author notes that the computation of the aerodynamic heating of the aircraft skin is a problem which, in a general case, lacks an exact analytic solution and in actual practice is solved in an approximate manner by means of rather simple methods of numerical integration. In this connection, he has considered a section of a smooth nonreinforced skin. The temperature T is assumed to be equal throughout the thickness of the skin and the heat transfer conditions are taken as slowly changing over the surface of the flying craft. Thus, the heat flows which propagate along the skin are disregarded. In a general case, the differential equation which describes the change in the skin temperature during a time interval is presented. Corresponding to this differential equation is a system of computation for a skin ideally heat-insulated from its inner surface. Author

N67-39181 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
DIFFERENTIAL EQUATIONS OF THERMAL STATE OF A BUSHING BLADE AND METHODS OF THEIR SOLUTION [DIFFERENTSIAL'NYYE URAVNENIYA TEMPERATURNOGO SOSTOYANIYA GIL'ZOVOY LOPATKI I METODY IKH RESHENIYA]
A. G. Zenukov *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 139–149 refs (See N67-39169 23-32)

The article is in two parts: the first deals with the derivation of the equations, the second with an approximate method for their solution. The following fundamental differential equations are derived: (1) a differential equation for the temperature state of the envelope, disregarding radiation heat and temperature change throughout the thickness of the envelope; (2) an equation describing the temperature state of the shaft core; and (3) equations describing the heating of the air in the first and second contours. The authors solved the equations for the following particular case: (1) thermoconductivity along the profile is infinitely great; (2) within the sections, into which the blade is broken down, the heat transfer factors from the gas and air in the second contour, as well as the temperatures of the gas, envelope, and air in that contour, are considered constant; (3) a case is considered in which the air is fed (to the second contour) through a series of apertures (this being the most convenient); (4) the effect of radiant heat transfer is disregarded; and (5) the absence of air reflow between adjacent sections is assumed. Author

N67-39182 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
CALCULATION OF HEATING OF A TWO-LAYERED INFINITE SLAB [RASCHET PROGREVA DVUKHSLOYNOY NEOGRANICHENNOY PLASTINY]
A. A. Kobylyanskiy *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 151–158 refs (See N67-39169 23-32)

The author considered the single-dimension problem of the heating of a twin-layer lamina, consisting of thermal insulation and a metal skin, with the lamina subjected to convective heating from the insulation side. It is noted that similar conditions arise during the heating of the skin of aircraft, protected externally by a heat-resistant covering. The thermo-physical characteristics of the layers are assumed to be independent of temperature. The heat transfer factor is taken to be constant, with the environmental temperature a function of time. It is likewise assumed that the convective heat flow, transmitted from the boundary layer to the outer surface of the insulation, goes only to heat the lamina; the inner plate surface is considered to be heat insulated. The temperature in the skin depends practically on time alone, and not on the coordinate. Author

N67-39184 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
NONSTATIONARY PROBLEM OF THE THEORY OF THERMAL CONDUCTION FOR A HOLLOW CYLINDER [NESTATSIONARNAYA ZADACHA TEORII TEPLOPROVODNOSTI DLYA POLOGO TSILINDRA]
S. M. Kotlyar *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 171–176 (See N67-39169 23-32)

The article contains an analytical investigation of the axiosymmetrical temperature field of a hollow, circular cylinder of finite length with the condition that between the lateral surface of the cylinder and the surrounding medium, heat transfer occurs according to Newton's law, while at the ends and on the internal lateral surface of the cylinder heat transfer is absent. Author

N67-39185 Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
TEMPERATURE FIELD OF A SYSTEM OF BODIES HAVING A REGION OF EQUALIZED TEMPERATURE [TEMPERATURNOYE POLE SISTEMY TEL, IMEYUSHCHEY OBLASTI VYRAVNENNOY TEMPERATURY]
N. I. Nikitenko and L. I. Nikitenko *In its* News of Inst. of Higher Learning. Aeron. Eng. 27 Apr. 1967 p 177–184 refs (See N67-39169 23-32)

Two specific problems are considered in this paper. The first, of interest in connection with computations of the thermal state of aircraft skins, is formulated as follows: two unlimited plates are in contact, one of them being a region of equalized temperature. On the outer boundary of the nonmetallic plate a constant temperature t_f is maintained, with boundary conditions of the third order occurring on the inner boundary of the plate. At the initial moment of time, the system is considered to be in an unbalanced stationary state when the temperature of the metal t_0 = const $\neq t_f$. In the next section of the paper, the problem is posed in the following, more general formulation: a certain system consists of a finite number of solid bodies in contact, a part of which represent regions of equalized temperature. Author

N67-39245# California Univ., Livermore. Lawrence Radiation Lab.
MEASURING TRANSIENT SURFACE TEMPERATURES WITH COATINGS OF TEMPERATURE-INDICATING MATERIALS

Robert Parker 3 Apr. 1967 7 p refs Presented at the 22nd Instr.-Automation Conf. and Exhibit, Chicago, 11–14 Sep. 1967
(Contract W-7405-ENG-48)
(UCRL-70397; CONF-670903-1) CFSTI: HC$3.00/MF$0.65

In many pulse reactor experiments, the principal variable to be measured is the maximum surface temperature of some critical components. Hence, temperature-indicating materials may be advantageously used for this type of transient measurement. However, little is known of these materials when they are used to measure temperature under transient heating conditions. The energy stored in a low-inductance, high-voltage capacitor bank was discharged through a tapered stainless steel strip. The strip was heated in approximately 30 msec to some high temperature, which was measured with thermocouples and recorded with oscilloscopes. The strips were coated with various types of temperature indicators to evaluate the sensitivity and accuracy of the materials. In addition, high-speed color photography was employed to determine how quickly the indicators responded. In general, the speed and accuracy of Tempilaq, which undergoes a solid to liquid phase change, was superior to some other indicators. It was also concluded that thinner coatings responded faster (7 msec) to a sharp temperature rise. Author (NSA)

N67-39259# Mississippi Univ., University.
VIBRATIONAL RELAXATION IN CO_2/D_2O MIXTURES
F. Douglas Shields and James Alton Burks 15 Aug. 1967 22 p refs
(Contract Nonr-3078(01))
(AD-657198)

Sound absorption and velocity measurements were made in carbon dioxide/heavy water mixtures at 300, 400, and 500K. The results show that D2O is from 1/3 to 1/5 as efficient as H2O in de-exciting the bending mode vibration of CO2 in a molecular collision. The collision efficiency of D2O for de-exciting CO2 decreases with temperature at an even greater rate than does that of H2O. The large difference between D2O and H2O invalidates the chemical affinity explanation of effect of H2O on CO2. An approximate semi-classical calculation of the transition probability indicates that it is possible to attribute the relaxation to an interchange between the vibration of the CO2 and the rotation of the H2O or D2O. Author (TAB)

N67-39270# General American Transportation Corp., Niles, Ill. General American Research Div.
DETONABLE GAS EXPLOSION; A UNIQUE APPLICATION
M. J. Balcerzak *In* AFCRL Proc., 4th AFCRL Sci. Balloon Symp. Jan. 1967 p 99–115 (See N67-39261 23-02)

Detonable gas explosion is a blast and shock simulation technique utilizing the spherical detonation of a combustible gas mixture initially contained in a balloon to generate shock waves. These resultant shock waves are similar in nature to those produced by conventional high explosives or nuclear explosions. The largest detonable gas explosion produced to date has been the equivalent of 20 tons of TNT. This explosion required a 125-ft diam hemisphere filled with a detonable propane–oxygen gas mixture. Studies are currently under way to use the detonable gas explosion technique as a high-altitude blast generation system. Consideration is also being given to extending the yield of the hemispherical detonable gas explosion to the 500-ton TNT equivalent range. This would require a hemisphere on the order of 385 ft in diam. Author

N67-39338 Centre National de la Recherche Scientifique, Meudon (France). Laboratoire d'Aerothermique.
THEORY OF SMALL PERTURBATIONS FOR FLOWS BEYOND EQUILIBRIUM. VOLUME I: THERMODYNAMICS [THEORIE DES PETITES PERTURBATIONS POUR DES ECOULEMENTS HORS D'EQUILIBRE. FASCICULE I: THERMODYNAMIQUE]
Luigi G. Napolitano and Alain Beaune Jul. 1967 149 p In FRENCH
(Rept.-67-4; Publ.-296)

Thermodynamic theory is considered for systems that are in equilibrium or thermostatic states, and the theory of small perturbations is applied to flows that are beyond equilibrium. The thermodynamics of processes beyond equilibrium is discussed in terms of a fundamental hypothesis, general equations for fluid dynamics, irreversible linear processes, and applications to closed local systems. General properties for the thermodynamic equations related to small perturbations are included, as well as non-dimensional equations and the Crocco energy equation. A section on linear small perturbations covers flow around a spinder body and plane wave propagation of weak amplitude in an infinite medium; and acoustic nonlinear and transonic nonlinear flows are discussed. Transl. by M.W.R.

34 GENERAL

Includes reports of a broad nature related to industrial applications and technology, and to basic research; defense aspects; law and related legal matters; and legislative hearings and documents.

N67-38508# National Academy of Sciences—National Research Council, Washington, D. C.
APPLIED SCIENCE AND TECHNOLOGICAL PROGRESS
Jun. 1967 432 p refs
GPO: $1.50

The complex relationships among government, science, technology, society, and individuals are considered in a series of reports on applied science and technological progress in the United States. Prepared by the National Academy of Sciences for the House Committee on Science and Astronautics, the report includes papers on various aspects of applied and basic research in both the biological and physical sciences. Technology transfer and technological innovations are treated, costs to industry and economic growth from innovations are cited, and problems in engineering education and computer-aided learning are discussed by various members who comprised the NAS panel charged with this investigation. M.W.R.

N67-38509# National Academy of Sciences—National Research Council, Washington, D. C.
APPLIED RESEARCH DEFINITIONS, CONCEPTS, THEMES
Harvey Brooks *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 21–55 refs (See N67-38508 23-34)

A digest of ideas related to applied research definition and concepts is presented in ten different sections. Distinctions between basic and applied research, as well as the indivisibility of the research and development procedure are discussed. The evolving nature of the relationship between research and technology is treated, along with the roles of government, industry, and the university population. A distinction is then made between science and technology, and the increasing trend toward conceptualization in technology is considered. Attention is given to the use of the attitudes and methods of fundamental research in dealing with applied problems, political and administrative decision making concerning technology or the involvement of nonscientists in making technological judgments, and the so-called mission-oriented laboratory. The problems of assessing the quality of applied research and the need for better documentation procedures are noted, and

the roles of the administrator and the entrepreneur in the overall research program are considered. M.W.R.

N67-38511# National Academy of Sciences—National Research Council, Washington, D. C.
THE SYSTEMS APPROACH
Hendrick W. Bode *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 73–135 refs (See N67-38508 23-34)

Systems engineering is discussed as one of the aspects of applied research that has influenced both military and nonmilitary efforts. Varying conceptions of systems engineering are noted, and the relationship of systems engineering to the overall engineering structure is noted. Some of the more important characteristics of systems engineering are discussed, and the fact that this field of endeavor always deals with interdisciplinary problems is stressed. Systems engineering and the Bell System approach are noted, and examples dealing with microwave relay systems and the Nike–Ajax are included. M.W.R.

N67-38512# National Academy of Sciences—National Research Council, Washington, D. C.
CRITERIA FOR COMPANY INVESTMENT IN RESEARCH, WITH PARTICULAR REFERENCE TO THE CHEMICAL INDUSTRY
Harold Gershinowitz *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 137–151 refs (See N67-38508 23-34)

Research is considered a company activity that makes it possible to increase profits, and the close cooperation between the manufacturing and marketing departments and the research department is stressed as the means of implementing the profitable use of innovations. Criteria for decisions as to the future of research are listed in terms of the chemical industry's needs, but are considered applicable to other industries. Science-oriented research is distinguished from business-oriented research in the form of process, raw material, product, or customer oriented activities. The role of government is stressed, and the duplication of some government and industrial efforts is noted. M.W.R.

N67-38516# National Academy of Sciences—National Research Council, Washington, D. C.
THE ENVIRONMENTAL SCIENCES AND NATIONAL GOALS
Preston E. Cloud, Jr. and V. E. McKelvey *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 229–254 refs (See N67-38508 23-34)

Environmental engineering is considered as the application of environmental science for the benefit of mankind; and, in view of the special concern of the Federal Government in this area, the nature and relationships of the environmental sciences are discussed with emphasis on the attainment of national goals. A general strategy is noted for bringing environmental science to bear on national goals, and consideration is given to the identification of practicable objectives and soluble problems. Analysis of various alternatives and costs is considered in this light, and the selection of programs for Federal support is discussed. The balance of funds allocated to research and development activities is mentioned, and attention is given to the management of Federal research in the environmental sciences. A section is devoted to the sources and conservation of brain power in engineering and science, and the optimum use of creative talent is stressed. M.W.R.

N67-38517# National Academy of Sciences—National Research Council, Washington, D. C.
APPLIED SCIENCE AND MANUFACTURING TECHNOLOGY
Donald N. Frey and J. E. Goldman *In its* Appl. Sci. and Technol. Progr., Jun. 1967 p 255–295 ref (See N67-38508 23-34)

Product-process relationships, the character of applied research in manufacturing technology, applied research and reliability, and avenues for governmental action are treated in terms of gains to the manufacturing community. Automatic process control is related to the role of systems design and computers in manufacturing processes, simple control systems in manufacturing, and complex manufacturing systems. Illustrative examples of innovations deal with high pressure metal forming, titanium carbide cutting tools, the synthetic polymers corfam and nylon, electrocoating process on automobiles, radiation curing of polymers, the basic oxygen furnace in steel making, and zone refining and the transistor. The dependence of microelectronics on advanced manufacturing technology is illustrated, and other innovations deal with thin wall iron castings for automotive cylinder blocks and a disk armature type motor. These examples are included to stress the increasing dependence of manufacturing research on contemporary science, and the need for disseminating information on improved technological developments. M.W.R.

N67-38518# National Academy of Sciences—National Research Council, Washington, D. C.
CASES OF RESEARCH AND DEVELOPMENT IN A DIVERSIFIED COMPANY
C. Guy Suits and Arthur M. Bueche *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 297–346 refs (See N67-38508 23-34)

Research and development for a large diversified industrial complex that is geographically and managerially decentralized are discussed, and the activities at the central corporate laboratory are mentioned. Details are included for the synthesis of man-made diamonds, and it is noted that elapsed time from the beginning of the research project to commercial production was less than six years. Aside from the synthetic diamond "mine" now available in Detroit for industrial uses, there have been two major byproducts of this research effort. Superpressure work, as involved in diamond synthesis, has become a major project at laboratories around the world; and the researchers at the original laboratory have created 30 more new forms of matter. M.W.R.

N67-38519# National Academy of Sciences—National Research Council, Washington, D. C.
TECHNOLOGY TRANSFER
Charles Kimball *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 347–356 (See N67-38508 23-34)

Transfer of technology originally developed for atomic energy, defense, and space is discussed in terms of use by both the private and public sectors of the community; and uses that are quite different from those envisioned in the original mission-oriented programs are noted. In addition to technological transfer of products and processes dealing with aircraft, radar, computers, inorganic coatings, etc., there have been transfers of management technology to industrial complexes. Conclusions concerning the transfer process are stated as the need for receptivity for innovation, the necessity of problem definition, and investigation of the transfer process itself. Barriers to transfer are noted as the human resistance to change, inadequate skills and narrow viewpoints, and poor producer–user relationships. The social and economic form and purpose of the technology transfer process is noted, and the need for adequate transfer agents is stressed. M.W.R.

N67-38520# National Academy of Sciences—National Research Council, Washington, D. C.
TECHNOLOGICAL INNOVATION AND ECONOMIC GROWTH
Robert A. Charpie *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 357–364 ref (See N67-38508 23-34)

The development of new industries based on technological innovations during the past 25 years is noted, and the role of productivity gains from new technology is stressed as the major factor in the constant dollar growth of the gross national product of the United States. Growth patterns in the United States and other countries are compared, and the diversity of routes toward achieving a high degree of industrialization is noted. Technological innovation is discussed as both an evolutionary and a revolutionary process, and the overall gains to society from innovative efforts are stressed. Roles of both the entrepreneur and the capitalist are discussed, and the time value of money is emphasized. M.W.R.

N67-38521# National Academy of Sciences—National Research Council, Washington, D. C.

THE EVOLUTION AND PROSPECTS FOR APPLIED PHYSICAL SCIENCE IN THE UNITED STATES

Edward Teller *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 385–397 (See N67-38508 23-34)

The present leadership of the United States in pure or basic science is noted, and the role of applied science in shaping world civilization is stressed in terms of evaluating the applied science posture of the United States. The discussion is in the form of answers to a series of questions posed by the National Academy of Sciences, including consideration of the proper balance between applied and basic research to meet both military and civilian national goals. The relationship of applied research to specific projects, training of applied scientists, and attracting better minds into the applied physics field are discussed. Attention is also given to the effectiveness of both industrial and federal laboratories in the performance of their missions and some of the most significant achievements of applied science throughout the world. Another question deals with whether the United States should strive to maintain a very broad spectrum of capabilities in applied science, or if it should concentrate on fewer goals with the maximum possible effort in each. The final question asks about criteria for determining whether a new technology is ripe for exploitation on a large scale. M.W.R.

N67-38522# National Academy of Sciences—National Research Council, Washington, D. C.

A NOTE ON ENGINEERING EDUCATION

C. Richard Soderberg *In its* Appl. Sci. and Technol. Progr. Jun. 1967 p 399–413 ref (See N67-38508 23-34)

Some characteristics of engineering education in the United States are discussed in the framework of generalists versus specialists, and it is noted that much of the deficiency in this educational process can be made up in on-the-job training and experience acquired after graduation. The social and economic motivations of the technological society are also considered to deter the full exploitation of technology utilization. Some means for strengthening the professional elements of engineering education are noted, including (1) use of adjunct professors who spend the majority of their time in industry or consulting, (2) use of engineering faculty to provide technical services to the university itself, (3) creation of cooperative research and development projects between universities and mission-oriented institutions such as industry, (4) creation of multidisciplinary government mission-oriented research institutions in close association with universities, and (5) the subcontracting design problems to engineering departments by industry or government agencies. M.W.R.

N67-38594# Joint Publications Research Service, Washington, D. C.

APPLIED MATHEMATICS, COMPUTERS, AND INFORMATION MODELS

N. Moiseyev and N. Amosov 11 Sep. 1967 36 p Transl. into ENGLISH from Nauka i Zhizn' (Moscow), no. 7, Jul. 1967 p 16–24, 46–54
(JPRS-42537; TT-67-33165) CFSTI: $3.00

CONTENTS:

1. IN DEFENSE OF APPLIED MATHEMATICS N. Moiseyev p 1–16 (See N67-38595 23-19)
2. SIMULATION—A TOOL IN MAKING FORECASTS AND IN CONTROL N. Amosov p 17–31 (See N67-38596 23-34)

N67-38596# Joint Publications Research Service, Washington, D. C.

SIMULATION—A TOOL IN MAKING FORECASTS AND IN CONTROL

N. Amosov *In its* Appl. Math., Computers, and Inform. Models 11 Sep. 1967 p 17–31 (See N67-38594 23-34)

Mathematical representations of the human and so-called world systems; and the cybernetic control of these systems for influencing society are discussed. Hypothetical flow chart diagrams of the man and world systems are presented. The susceptibility of the man system to the effect of training and education, with the resulting implications to the world system, is discussed. L.S.

N67-38870# New Mexico Univ., Albuquerque. Technology Application Center.

AN ANALYSIS OF SYSTEM CRITERIA AND IMPLEMENTATION COSTS FOR AN ADVANCED COMPUTERIZED INFORMATION RETRIEVAL SYSTEM

R. D. Eck and W. A. Shinnick 1 Apr. 1967 15 p
(Contract NSR-32-004-013)
(NASA-CR-84648) CSCL 05B

The role of the Technology Application Center is appraised based on its operating experiences, developments in information dissemination procedures, and the information requirements of the greater Southwest market. Increased competition for the community's information purchasing dollars, and constraints on in-house computerized data retrieval services are cited as limiting factors. The types of computer capabilities required are outlined in terms of responsiveness in satisfying requests; providing minimum cost methods for the communication of information availability; internal efficiency by minimizing the time spent in reviewing irrelevant documents, and maximizing the availability of the professional staff for creative applications efforts; and offering computerized services for regional programs. An analysis of the anticipated costs of implementing and operating the proposed system is included. M.G.J.

N67-38941* California Univ., Berkeley. Center for Research in Management Science.

A DYNAMIC INPUT-OUTPUT MODEL OF THE CALIFORNIA EDUCATIONAL SYSTEM

Lawrence P. Nordell Aug. 1967 122 p refs
(Grant NsG-243; Contract Nonr-222(77))
(NASA-CR-89274; TR-26) CSCL 05I

The correlation of good general educational variables to economic variables (e.g. productivity, nonuniformity of work quality, etc.) is discussed. A dynamic programming input-output model oriented towards educational planning, from the perspective of either an economic planner or an educational administrator, is presented. Class size, manpower orientation, projected industrial demand, occupational classifications, achievement levels, curriculum, and enrollments, are among factors considered in the model. All levels of education are included in the planning. L.S.

N67-38944* Wayne State Univ., Detroit, Mich. Center for Application of Sciences and Technology.

THE APPLICATION OF AEROSPACE TECHNOLOGY TO URBAN MANAGEMENT

[1966] 95 p refs

(Contract NSR-23-006-034)

(NASA-CR-89307) CSCL 05C

A program was initiated to test the hypothesis that aerospace related science and technology have urban management applications, and can be efficiently utilized by local govenment. Concepts and procedures which appear to be necessary for the efficient design and operation of the program were postulated. Some of the potentials and limitations of applying the aerospace technology to urban management are defined. Specific urban problem areas which appear to be resolvable through the application of aerospace generated technology are identified. L.S.

N67-39198# Library of Congress, Washington, D. C. Aerospace Technology Div.

FOREIGN SCIENCE BULLETIN, VOLUME 3, NUMBER 8 Monthly Review of Selected Foreign Scientific and Technical Literature

Aug. 1967 112 p refs

Major Soviet scientific achievements during 1966 in physics, mathematics, cybernetics, the geosciences and astronomy, chemistry, the life sciences, and in materials research, metallurgy, and metal working are discussed. Two separate articles are presented on the improvement of masers and the expansion of their application in the U.S.S.R., and on the work of the Aviation and Space Medicine Section of the Moscow Physiological Society in 1966. Three brief notes cover the electromyographic study of speech, a T-shaped radiotelescope operating in the 10–25 MHz range with electrically steered beam, and a Michelson laser interferometer. Also presented are notes on a man–machine symposium and on a plenary session of the Scientific Council on the Comprehensive Investigation of the Earth's Crust and the Upper Mantle. K.W.

N67-39199*# National Aeronautics and Space Administration. Manned Spacecraft Center, Houston, Tex.

TENTATIVE PROGRAM FOR RESEARCH AND ANALYSIS OF ORGANIZATIONAL BEHAVIOR AND ADMINISTRATION OF SCIENTIFIC AND ENGINEERING FACILITIES

R. S. Jurslewicz (Minnesota Univ.) 31 Aug. 1967 19 p refs

(NASA-TM-X-60441; MSC-BA-MR-67-1) CFSTI: HC $3.00/MF $0.65 CSCL 05A

Presented are ideas and concepts on a possible approach for the investigation and study of scientific and engineering facilities based essentially on a collection of thoughts stemming from current literature on research management and management of scientific personnel. Although the orientation of the approach is behavioral, an attempt was made to incorporate traditional or conventional management concepts and to employ a total systems concept to the study. The main objectives of this research project are: (1) to develop a research model for in-depth study of organizational modes and management techniques existing in research and engineering facilities; (2) use the model to analyze existing facilities or laboratories; and (3) identify the strengths, weaknesses, and functional characteristics of the facility's organization, making recommendations where applicable. This paper outlines a tentative program and an approach leading to the solidification of a research format to achieve these objectives. K.W.

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—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

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